Geographia Polonica

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Errata

Page/Line	*For*	*Read*
$6_{17/18}$	In very sandy soil containing quartz profiles iron,	In very sandy, quartzy soil profiles, iron,
6_9	on	an
7^{19}	The thickness of the sandstones observed	The observed thickness of the sandstones
156^{15}	of cattle of sheep	of cattle and of sheep

Fig. 1 (after page 172) should be:

2a — Rye with sugar-beet and the raising of dairy cattle,

2b — Rye with potatoes, fodder crops and the raising of dairy cattle (and pigs),

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EXFOLIATION IN A PERIGLACIAL CLIMATE

Zdzisław Czeppe

The opinion which has been expressed by W. Łoziński (1909), that in cold climates the processes of mechanical weathering are most intensive is widely accepted. The intensity of chemical processes diminishes with the decrease of temperature. It has, therefore, been theoretically assumed that chemical weathering in a periglacial climate develops very slowly and plays only a secondary role. This opinion, however, is not generally accepted. Overrating the role of mechanical weathering in the Arctic has been criticised by some authors e.g. H. Mortensen (1928), C. Troll (1944) and A. Rapp (1960). They point out that the characteristics of the climate of Spitsbergen, the classical area of arctic investigations are not very favourable to mechanical weathering. Considerably more favourable are the conditions in the high mountains of lower latitudes, where both the days of frost change are more numerous and the diurnal amplitudes of temperature are greater.

A. Cailleux (1961) has recently described very interesting weathering forms of rocks in the McMurdo Sound region (Antarctica). He distinguished forms generated by frost fracturing by granular disintegration, by alveolar erosion and even by exfoliation. In his opinion, the origin of these forms is not only the result of frost weathering processes (freeze and thaw), but it is also influenced by chemical processes. Mineral efflorescences, concretions and coatings occuring on the surface of rocks furnish unquestionable evidence of chemical action. Cailleux distinguished coatings and efflorescences of mirabilite (hydrated sodium sulphate), occuring commonly in this region, as well as calcerous, ferrugineous and probably silicic coatings. Mirabilite efflorescences dissolve easily in water and then reappear. In Cailleux's opinion, therefore the process of frequently recurring crystallization of this mineral may be an important agent in rock weathering.

Some data concerning the problem of chemical weathering in arctic conditions are contained in the results of investigations on soil-forming processes. The pedologic research is rather difficult, because the waste mantle in arctic regions is usually thin, rocky, water impregnated and displaced by frost processes, mass movements etc. Thus it is difficult to obtain a complete soil profile. Nevertheless E. Blanck, A. Rieser and H. Mortensen (1928) have observed on Spitsbergen chemical weathering, restricted to the solution of carbonates. Simultaneously no traces of silicate weathering were observed. In the opinion of these authors the annual higher temperature periods there are too short for sufficient development of hydrolysis to occur. Meinardus (1930) observed on Spitsbergen the weak podzolic character of the regional soil-forming process. In some soils he observed distinct processes of iron oxidation and dissolution of carbonates. According to Sochava (1937) there are some calcerous C horizons within the soils of the Anabar River Basin, whilst their upper levels do not effervesce when treated with hydrochloric acid. Polyntseva and Ivanova (1936) described a poorly developed illuvial horizon in the tundra soil of Khibiny. It is formed by mobilised iron, secondary silicates and organic-alumina complexes. Drew and Tedrow (1957) confirmed the results of Meinnardus observations and showed, that in the soil profile there is a slight displacement of iron, aluminium and manganese as well as leaching of dolomite in the upper horizons. In the brown soils of Alaska, Hill and Tedrow (1961) noticed the solution of carbonates on the surface and their reprecipitation in lower strata of the soil profile. Moreover the oxidation of iron-bearing minerals is marked near the surface. In very sandy soil containing quartz profiles iron, aluminium and manganese are partly mobilised and translocation occurs. The clay fraction of the soil is composed chiefly of hydrated mica, accompanied by kaolinite, quartz, goethite and feldspar.

Thus the existence of soil-forming processes in the Arctic is not only proved but also its character is to some extent defined. During his geomorphological investigations on the NW coast of Sörkappland (Vestspitsbergen) in 1960, the author of this work observed some exfoliation forms on sandstones, indicating, that the chemical weathering processes are acting also within the bedrock.

North of the Palffyodden penninsula, about 150 m from the outlet of Snipevatna there is a small trapper's hut standing on the 7 m marine terrace. In a southerly direction from this hut the surface of the terrace rises to approximately 9 m and below the surface gravel appears on abrasion surface, cut in sandstone of Carboniferous age[1]. To the west, the terrace drops perpendicularly 4 m to the lower, contemporaneously accumulated terrace. The latter is approximately 50 m wide and its surface rises from 3.5 m on the sea coast to 4.5 m at the foot of the cliff. Along the terrace two parallel

[1] The discussed sandstones belong to the Hornsundneset Beds, regarded previously to be of Lower Carboniferous age. On the basis of recent microspore determination they are assigned to the Namurian Stage (S. Siedlecki, E. Turnau, "Preliminary palynological investigations of Culm in the area of Hornsund, Vestspitsbergen" *Studia Geol. Polon.* 1963, in print).

storm ridges have developed, protecting the base of the cliff against erosion by heavy seas. The cliff is therefore not actually undermined. According to Feyling-Hanssen and Olsson (1955, 1960) this terrace, 7 to 9 m high, rising to the east up to 19 m a.s.l., belongs to the "Lower Astarte Terraces" group and became exposed during the Subboreal period. It is therefore a very young terrace and its sheer face was probably undermined not very long ago. On the surface of the terrace there occurs a compact, hard, fine-grained, distinctly layered quartzite sandstone of light-gray, almost white colour. The thickness of individual layers is 30-40 cm. Their strike is 113° and dip — 15° in a South Westerly direction. Strong fracturing, the main directions of which are 135° and 178° causes the disintegration of this rock into rhomboidal blocks, ranging in size from 10 to 100 cm (usually 30-80 cm), the thickness of which is that of a sandstone layer. On the cliff the thickness of sandstones reaches approximately 1.5 m. They rest discordantly on the darker, brownish-gray or violet, fine-or medium-grained quartzite sandstones. The thickness of layers of these rocks is approximately 20 cm, decreasing towards the top of the series. Further to the south gray and violet sandstones dip at an angle of 16° and above them yellowish-brown, fine-to medium-grained, cross-bedded sandstones appear. The thickness of the sandstones observed rapidly increases to approximately 2.6 m.

There is no meteorological station in this part of Spitsbergen. Some general information about the climate of this region may be deduced from the data of Green Harbour Station, obtained for the period 1912-1927 (H. Knothe 1931). According to those data, the climate is characterised by small diurnal temperatur amplitude, especially in summer, whilst the annual amplitude is comparatively large. The average temperature of the warmest month (July) reaches 5.4° C. and of the coldest month (February) — 18.6°C. The average annual total precipitation is 309.8 mm, whilst the maximum recorded is 452.2 mm (1927). The maximum monthly total is approximately 44 mm (December). The observations of the Polish I.G.Y. Scientific Station in Hornsund (1957-1958) showed, that the possibility of precipitation in the form of rain or sleet exists for approximately 6 months of the year. The upper stratum of soil, about 20 cm thick, thaws for all or part of a period of 5 months per year. The maximum depth of thaw observed in the course of the exceptionally warm and dry year of 1958 in comparatively well drained, sandy formations, is approximately 1.8 m (Z. Czeppe 1961). It should however, be remembered that individual elements of the Vestspitsbergen climate are very variable from year to year and are also dependent on local conditions. The Palffyodden is far more strongly influenced by the sea than Green Harbour and lies approximately 140 km further south. The seashore is protected by mountains from cold, easterly winds, which are so active in the exposed region of the Polish Station in Hornsund. Thus the climatological conditions in the Palffyodden region are supposedly a little milder than in both the above mentioned stations.

The vegetation on the surface of the terraces is very poor. It occurs in patches and in isolated tufts. The greater part of the discussed region consists of bare rock surfaces, sometimes covered with a thin layer of debris and gravel. Within the area in which exfoliation forms occur, the terrace is well drained by fissures. This is probably the cause of a comparatively deep thaw. The presence of so many fissures accounts for the rocks being well aërated.

On the surface of the terrace, built up of quartzite sandstones, the effects of frost fracturing can be observed. This phenomenon favors the enlargement and deepening of fissures. Consequently the latter sometimes become trenches, the width and depth of which sometimes exceed 2 m. The action of thaw waters also enlarges the bedding fissure to which they migrate. In the main direction of flow longtitudinal surface depressions are formed and on joints of fissures funnel-shaped hollows develop. This is probably the result of a considerably advanced mechanical disintegration of rock debris, which is then carried out by water, flowing along the fissures.

Quite different is the course of weathering process of gray, violet and yellow sandstones. The exposed rocky surfaces and the surfaces created by cracks and bedding fissures become darker in colour and harder than the unweathered rock. Subsequently the hardened shell splits off. Its thickness is approximately 4 mm. Sometimes two or three shells form successively. The first is usually the darkest and the hardest. In the course of further weathering, thin and fairly brittle flakes are formed, which easily fall off. Consequently the block becomes rounded. The fissures form a dense net with the mesh size of 20 to 30 cm. Since the thickness of the rock layers is similar, they are in fact disintegrated into cube-shaped blocks. In the course of weathering they assume irregular rounded shapes and the exposed rock surface resembles an old pavement. Yellow, cross-bedded sandstones are not fractured. In these rocks an outer shell forms along the bedding surfaces. Consequently lenticular elements develop.

Sandstone samples were subjected to mineralogical, microscope and chemical examinations[2]. They showed, that the discussed sandstones are composed of both well-and ill-rounded quartz grains, the average diameter of which is 0.05 to 0.07 mm. Sometimes, particularly in the gray variety, numerous muscovite flakes are observed, which are curved due to weathering processes. In addition tourmaline, zircon and garnet are noted. Sandstone cement is calcerous or ferruginous, depending on the degree of weathering .The weathering processes affect the cementing substances and depend on the leaching of siderite and oxidation of iron and their migration to the surface and exterior

[2] The mineralogical and chemical examinations of sandstone samples were carried out by Maria Krysowska in the Department of Mineralogy and Petrography of the Jagellonian University in Krakow. The author is much obliged to her for friendly cooperation.

Fig. 1. The cliff face. The lower part is composed of gray sandstones, exfoliating along fissures. Above are quartzitic sandstones. Locality: Palffyodden, Sörkappland, Vestspitsbergen.

Fig. 2. The surface of a layer of gray sandstone. The shells accompanying fissures and roundish shape of weathering blocks are clearly visible.

Fig. 3. The surface of a layer of gray sandstone. Note the shells along fissures and flaking of the core of a block

Fig. 4. Yellow-brown, cross-bedded sandstones. The shells are forming parallel to the bedding-surfaces

of the block. Consequently four concentric zones may be distinguished within the marginal zone of a weathering sandstone block:

1. Inner sideritic zone, unweathered, with sideritic cement. Siderite rhomboeders are usually slightly brownish because of the initiation of the weathering process.

2. Goethitic zone, weathered, characterised by hematitic or goethitic cement and blackish-brown in colour. This cement is concentrated locally and forms a coating round the quartz grains. Sporadically siderite crystals are observed. Opal and chalcedony are more abundant than in the unweathered zone.

3. Limonitic zone, forms a clearly visible weathered ring around the former one. Limonitic cement fills the space between the quartz grains. Iron oxides are most probably completely hydrated. Opal and chalcedony are abundant.

4. Chalcedonic zone, weathered, almost completely deprived of iron with only traces of limonitic cement. The main cementing substance is chalcedony and amorphous silica, impregnated with iron oxides.

The percentage weight of ferrous and ferric iron content in individual zones of weathering is as follows:

zone	FeO	Fe_2O_3
Sideritic	3·34	7·20
Goethitic	0·35	9·21
Limonitic	0·20	3·13
Chalcedonic	0·15	0·78

The content of iron compounds evidently decreases with the progress of the weathering process. Ferrous iron occurs only in the unweathered part of the sandstone, being developed in the carbonate form. Within the remaining zones its content is negligible due to the oxidation of ferrous compounds. Because of the action of carbonic and humic acids the greater part of the iron is removed outside the rock. Organic acids also decompose silicate minerals and remove iron, aluminium and manganese from their structures. Consequently the colloideal silica (opal) is left, partly recrystallising into chalcedony. The iron-impoverished zone is dark in colour, because of hydration of hematite or goethite into limonite. The increased hardness of this zone is due to the replacement of ferrouginous cement by silica.

A. Cailleux (1961, pp. 23-24) describes exfoliation of granite, gneiss and marble boulders. Regarding the origin of this phenomenon he briefly puts forward two hypotheses: *gel probablement; peut-être mirabilite*. The above investigations prove, at least in the case of Carboniferous sandstones of Spitsbergen, that exfoliation is the result of a chemical process. There are no sufficient data to determine the role played by mechanical weathering in this process. It probably accelerates the splitting of the shells. Nevertheless, the facts presented above allow one to conclude, that in a peryglacial climate, besides the already known chemical processes of a soil-forming character, under suitable local conditions relatively intense chemical weathering processes may also operate within solid rocks.

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ON THE EFFECT OF THE PREGLACIAL RELIEF ON THE COURSE AND THE MAGNITUDE OF GLACIAL EROSION IN THE TATRA MOUNTAINS

Mieczysław Klimaszewski

The problem of glacial erosion is dealt with by geomorphologists, geologists and geophysicists since more than 100 years, but the magnitude of glacial scouring is hitherto estimated very differently. According to, "glacialists", the efficacy of glacial erosion is very great and the result of this process are glacier troughs, glacial cirques and land forms produced by over-deepening by glaciers, i.e. rock basins, channels and steps. The "antiglacialists" contested the carving activity of glaciers, and the development of the so-called glacial forms they ascribed to the effect of subglacial waters, marginal streams and mass movements. Finally, the supporters of "transformation" believe that the destructive activity of glaciers is limited to transformation of older (preglacial and interglacial) forms and that the magnitude of glacial carving and transformation depends on

a) the type of glaciation and the size of the glaciers (Ahlmann),

b) the pattern of movement of the firn-ice masses (Finsterwalder, Pillewizer, Louis, Carol, Nye, Streiff-Becker, Seligmann),

c) the duration of the glaciation (Engeln, Nussbaum),

d) the resistance and the properties of the substratum (Flint, Sölch),

e) the preglacial relief (De Martonne, Burchard, Ahlmann, Nangeroni, Sölch, Klimaszewski).

No decisive solution of this controversy was reached by the International Congress of Geography at Amsterdam (1938), during which a number of reports dealt with the problem of glacial erosion [2]. However, the remarkable results of recent research must have been an incentive towards putting forth this problem at the congress held at present.

Results of investigations in the scope of the glacial geomorphology of the Tatra Mts.

Compared with the Alps, the Tatra Mts. are a small mountain massif; still, here appear all forms known from the Alps. Their dimensions are much smaller, but their shapes are very typical. In virtue of this fact, various problems of glacial morphology can be better investigated and easier explained with the Tatra model as example.

My own investigations comprised field studies and mapping on a 1 : 10.000 scale of all forms appearing in the Tatra Massif and showing a defined origin and a determined age [6]. This research made it possible to recognize not only the distribution of forms of different origin and various age but also to define their mutual relation: of Pleistocene-glacial to Pliocene-preglacial forms and the relation of Holocene to Pleistocene forms. This data enable us to establish the magnitude of the transforming activity of glaciers as well as of the transforming activity of late-glacial and Holocene agencies [7, 8, 9].

Our investigations so far made imply that the extent of glacial erosion depends on the magnitude of glaciation, and that the magnitude of glaciation in turn depends mainly on the preglacial relief of the glaciated area.

a) The preglacial relief. In the preglacial Tatra relief there came to light late-mature forms produced during the Lower Pliocene and younger forms of the Upper Pliocene period. The Lower Pliocene relief shows dome-shaped peaks and rounded ridges in the Western Tatra, upper sections of Tatra valleys hanging at altitudes from 1400 to 1800 m a.s.l. and numerous erosion surfaces of pediment type, penetrating by valleys into the interior of the Tatra Massif. In the Upper Pliocene there took place a carving apart and a rejuvenation of the relief of the Tatra Massif and its foreland, brought by oblique tectonic movements and climatic changes (Fig. 1). This dissection

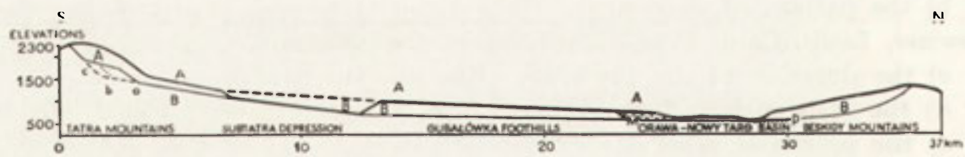

Fig. 1. Morphological section across the Tatra Mountains and Podhale
A — Lower Pliocene planation surface, M — Upper Miocene sediments in Domański Wierch, P — Middle and Upper Pliocene sediments at Mizerna, B — floors of Lower Pliocene river valleys, rejuvenated in the Upper Pliocene and deepened in the Pleistocene, a — completely rejuvenated in the Upper Pliocene, b — incompletely rejuvenated in the Upper Pliocene, c — only partly rejuvenated in the Upper Pliocene.

proceeding in an inverse direction, with diverse ranges depending on the resistance of the substratum, led to a complete or a partial rejuvenation of the valley forms. Due to this action, the long profiles of many Tatra valleys revealed a stepped pattern towards the end of the Pliocene. Sections of var-

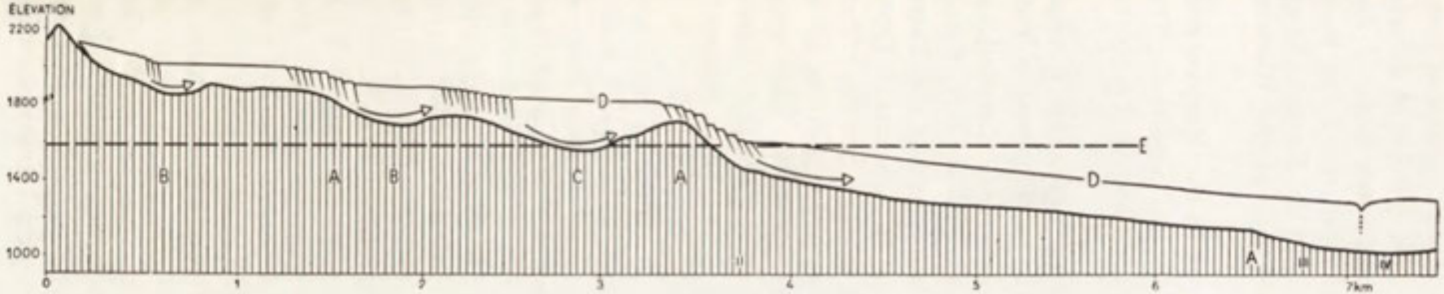

Fig. 2. Longitudinal profile of strongly transformed Dolina 5 Stawów Polskich (Valley of 5 Polish Lakes), Roztoki (Eastern Tatra Mountains)

A — erosive fluvial steps glacially transformed, B — rock basins sculptured by sliding ice masses, C — confluence basins, D — glacier surface during Würm period, E — snow line during Würm period, I, II — glacially transformed section of valley not rejuvenated in Upper Pliocene, II, III — glacially transformed section of valley rejuvenated in Upper Pliocene, III, IV — glacially transformed main valley, rejuvenated in Upper Pliocene and Lower Pleistocene

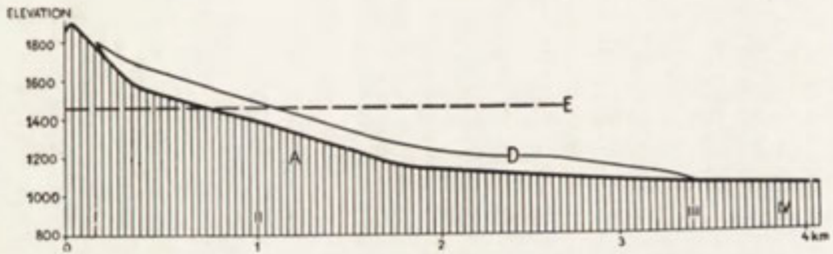

Fig. 3. Longitudinal profile of feebly transformed Kościeliska Valley (Western Tatra Mountains)

A — erosive fluvial steps glacially transformed, D — glacier surface during Würm period, E — snow line during Würm period, I, II — glacially transformed section of valley not rejuvenated in Upper Pliocene, II, III — glacially transformed section of valley rejuvenated in Upper Pliocene, III, IV — section of fluvial valley, rejuvenated in Upper Pliocene and Lower Pleistocene ious lengths of non-rejuvenated Lower Pliocene valleys were separated from sections rejuvenated during the Upper Pliocene by erosive steps of diverse heights. This dissection extended farher in the Western Tatra built of less resistant gneisses and metamorphic schists than in the Eastern Tatra built of granites of greater resistance. This is the reason why in the Eastern Tatra much longer sections of Lower Pliocene valleys survived than in the Western Tatra (Figs 2, 3).

The transverse profiles of valleys were also different in the Eastern and the Western Tatra at those times, depending on lithological conditions. The rejuvenated sections of Eastern Tatra valleys had already assumed a profile characterizing maturity (Profile _/).

b) Glacial modification. Thus developed the Tatra Mountains entered the glacial period. They suffered three glaciations during the Pleistocene. This number of glaciations can only be estimated on the basis of the distribution, the height and the preservation of the morainic and fluvioglacial covers found in the foreland of the Tatra Massif. On the other hand, within the Tatra Mts. themselves we distinctly observe traces of only the last glaciation. Even so, the large forms observed, like cirques and glacial troughs, are the effect of three glaciations superimposed on identical forms and resculpturing them at different degrees; the glacial cirques of the last glaciation also were cirques during the preceding glacial periods [8] — since the glaciations shrouded principally the forms developed before glaciation of the Tatra occurred, i.e. the preglacial relief as discussed above.

The preglacial Tatra sculpture predestined the accumulation of snow and the formation of firn fields in valley sections situated above snow line. Excellent basins of these snow masses became the high, non-rejuvenated sections of Lower Pliocene valleys. They were situated above the 500 m contour, thus above snow line during all three glaciations (Figs. 2, 3). Field studies in the Tatra Massif imply that, in the Pleistocene, only valleys partly rejuvenated suffered glaciation, whereas in valleys completely rejuvenated during the Upper Pliocene conditions were unfavourable to the accumulation of firn masses, so that these valleys were not glaciated (Fig. 4). Thus it must be concluded that glaciation of a mountain area presupposes not only suitable climatic conditions but appropriate morphological conditions also. And glaciation suffer mountains which during the preglacial period (the Pliocene) had undergone only partial rejuvenation.

c) Firn basins, developed in non-rejuvenated valley sections, were of diverse capacity, depending on valley lengths, widths and depths. Voluminous were basins comprising long sections of non-rejuvenated valleys surrounded by high ridges (Fig. 2), while of smaller capacity were basins of small dimensions fringed by lower ridges (Fig. 3). Basins filled with firn fields were transformed into glacier cirques, and the extent of their glacial transformation depended on the capacity of the basin and the volume of firn masses stored up in this basin. Large valley basins in which great masses of firn snow and glacier ice had accumulated, were strongly transformed and altered into typical glacial kettles and cirques (Eastern Tatra). On the other hand, small valley basins filled with firn of minor thickness were transformed less intensively

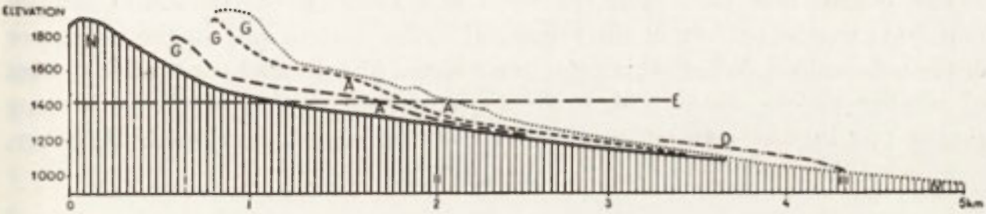

Fig. 4. Longitudinal profiles of glaciated (G) and non-glaciated (N) valleys in the Bystre drainage basin (Western Tatra Mountains)

A — erosive fluvial steps glacially transformed, E — snow line during Würm period, I, II, III, IV — identical as in profile Fig. 3

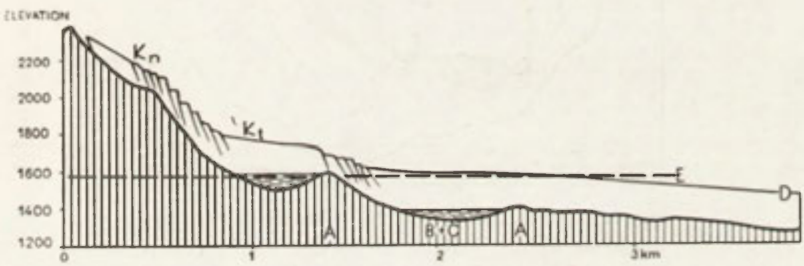

Fig. 5. Longitudinal profile across stepped cirques in the valley heads of Rybi Potok

Kn — cirques not overdeepened, Kt — cirques overdeepened, A — erosive fluvial steps glacially transformed, B — rock basins dug out by slides of ice masses, C — confluence basins, D — snow line during Würm period

(Western Tatra). This seems to indicate that the degree of transformation of firn basins mainly depends on the volume of the firn and ice masses accumulated.

Firn basins, formed by transformation of long sections of non-rejuvenated Lower Pliocene valleys (Eastern Tatra) are bordered by steep and, mostly, rocky walls; their floors are uneven, with protuberances and, frequently, deeply incised. In such deep depressions and channels, created by the scouring activity of glaciers, numerous lakes exist to this day. In the valley heads there occur stepped glacier cirques, lying one above the other (Fig. 5). Firn basins, developed by transformation of short sections of non-rejuvenated Lower Pliocene valleys, are surrounded by steep ridges, rarely rocky; here the valley floors are flat or inclined, but never overdeepened (Western Tatra).

An analysis of firn basins in the Tatra Mountains leads to the differentiation of

1) simple cirques, developed from the transformation of but one preglacial valley,
2) compound cirques, formed due to the transformation of several source valleys.

The course and the extent of the transformation of compound cirques depended on the pattern of the preglacial valley system and on the resistance of the substratum. Where this pattern consisted of a parallel-concentric system of smaller valleys, there took place a gradual demolition of the separating ridges, and in that way an uneven floor of the cirque developed. However,

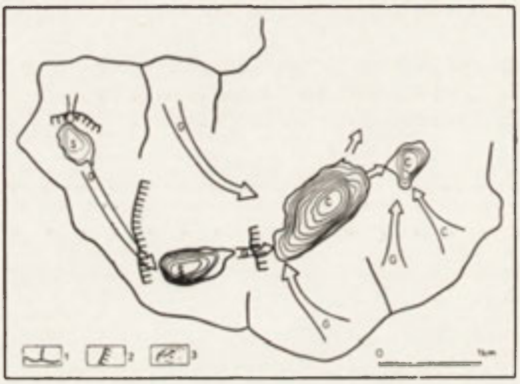

Fig. 6. Distribution of rock basins dug out by slides of glacier ice (S) and of confluence basins (C) in Dolina 5 Stawów Polskich (Valley of 5 Polish Lakes) with regard to direction of flow of firn and ice masses (G)
1 — ridges, 2 — steps, 3 — depth contour lines at 10 m intervals

where the pattern was dendriform, the masses that were flushed down from tributary valleys caused the formation of confluence hollows in the floor of the main valley; such confluence hollows show steeper slopes on the distal side (Fig. 6).

The firn basins observed in the Tatra Mts. are of the one-step (Fig. 4) or the multi-step type (Fig. 5). One step firn cirques (Western Tatra) usually show feeble symptoms of glacial transformation, whereas striking in the longitudinal profile of multi-step cirques is the feeble transformation of merely the highest cirque (lack of overdeepening) and, in contrast, a marked overdeepening of the lower cirques. Here are found glacial hollows with steeper proximal slopes. These hollows are caused by deepening erosion by firn and ice masses sliding or crashing down from the cirques above. In conformity with opinions previously expressed, there took place a deepening of the bases of the steep slopes separating the higher cirques from the lower ones; here, the ice masses sliding down these slopes attacked more vigorously the proximal sides and less intensively the distal sides (Fig. 6). A similar position and asymmetrical pattern show the potholes seen below steps of waterfalls, whereas confluence hollows show a different type of asymmetry.

The multi-step cirques, predetermined by the irregular (stepped) profile of preglacial valleys, were not developed by the last glaciation nor, by any means, by successive stages of the last glaciation (Lucerna). They represent part of the firn basins of the older glaciations and during the successive glaciations they constantly underwent resculpturing. Their most marked and typical forms must be ascribed to the last glaciation. These forms, already existing, were then utilized and partly transformed by the receding firn fields of the recession stages. This seems to indicate that the degree of glacial transformation depends not only on the preglacial relief but likewise on the duration of glaciation. Areas which suffered glaciation but once and during a shorter period of time show forms less typical than areas with repeated and longer-lasting glaciations.

The glacial modification consisted of a deepening and widening of the preglacial valley forms. However, the extent of deepening of firn basins varied very much during the three glacial periods. In the longitudinal profiles of many Eastern Tatra valleys we observe, next to each other, basins up to 80 m deep, evidence of strong overdeepening, and high rock-bars and hills indicating a feeble glacial erosion. Thus, in the same valley erosion took place quite differently, depending on the preglacial relief. Erosive deepening occurred at sites of glacier confluence and at the base of valley steps, whereas rock-bars and hillocks in the valley axis occur above the valley steps sections.

On the basis of a comparison of the depths of upper sections of non-glaciated, feebly glaciated (and feebly transformed) and heavily glaciated (and strongly transformed) valleys, and on the basis of their relation to the preglacial valley levels (and terraces) it is possible to estimate the magnitude of the Pleistocene deepening to be 100-150 m in the Eastern Tatra, and 50-100 m in the Western Tatra cirques. Lucerna [12] and Romer [18] assumed the deepening of the valleys during the Pleistocene to have amounted to some 400 m.

d) Glacial troughs. Upper valley sections, non-rejuvenated in the Upper Pliocene, were transformed at various degrees into glacial cirques by displaced masses of firn and ice. But lower valley sections, rejuvenated in the Upper Pliocene, were at various degrees transformed by the destructive action of valley glaciers. In the Eastern Tatra, from the wide and very capacious firn basins there flowed down into the preglacial valleys, being in a juvenile stage, large masses of ice with great velocity; thus, these valleys were strongly transformed and altered into glacial troughs. In the Western Tatra, on the other hand, there moved down, from small firn basins into valleys then at mature age, much smaller and thinner valley glaciers, moving at a greatly reduced velocity; due to this, these valleys were but slightly transformed.

The valley transformation discussed comprised their deepening and widening, and the formation of a trough's end. On the basis of the altitude of terraces in the non-glaciated sections, formed by proglacial waters during the various stages of glaciation, the deepening of the Tatra valleys may be estimated to amount to 50-60 m. These valleys were deepened not so much by glaciers than by proglacial waters, especially during cataglacial periods. As regards Holocene forms and processes, their analysis implies that during the interglacials the magnitude of destruction and transformation was also very limited. In the widening of the valleys the main part was played by weathering and rockfall, occurring principally during the anaglacial and cataglacial phases of each glaciation. During the maximum phases of glaciation, the glaciers carried off the loose material piled up in enormous talus cones; this material, embedded in the glacier ice, scraped off the valley sides thus producing U-shaped valleys.

The very characteristic trough's ends were not produced by the deepening action of glaciers joining each other (confluence steps), but were caused by glacial transformation of steps produced by fluvial erosion. These trough's ends are found at localities to which extended the Upper Pliocene backward erosion, very little augmented by erosion during interglacial periods.

With the exception of the confluence depression of Morskie Oko, the Tatra valleys lack forms produced by overdeepening. This lack may be due to the slower movement of the valley glaciers. This feeble erosive action of valley glaciers is also indicated by the preservation, in the lower valley sections, of older deposits underneath the morainic material; these deposits are anaglacial gravels and interglacial talus [9].

The glacial troughs show also a differentiation caused by the structure of the substratum. The upper sections of these troughs, incised in crystalline rocks, show a uniform width, while lower sections, dissecting rocks of diverse resistance, show widened and narrowed cross-sections. Here the valley glaciers adjusted themselves to the structure-controlled forms, leading alternately to widening and narrowing of the valleys, sometimes also connected with transfluence features. This again proves a feeble erosive action of valley glaciers which failed to cause a uniform widening of the lower valley sections.

In the Tatra we also observe the phenomenon of tributary valleys hanging high above the floor of the main valley. The lips of the hanging valleys indicate the range of interglacial regressive erosion and of the extent of the widening activity of the main glaciers.

Conclusion

The circumstances discussed above imply that in the Tatra Mountains glacial erosion proceeded in a manifold way and with varied intensity, depending on the preglacial relief and, especially, on the degree of rejuvenation and the magnitude of firns basins connected with this rejuvenation. The capacity of these basins determined the volume of firn masses retained; this volume, in turn, conditioned the lengths and thicknesses of the valley glaciers formed and both the rate and the character of their motion.

Considering the variety of forms of glacial erosion found in the Eastern and Western Tatra there can be assumed a variegated pattern of glacial erosion in the individual regions, even in separate valley sections. In the Eastern Tatra, the large accumulation of firn and ice slid down more rapidly and at a uniform rate within the range of the total transverse profile; consequently the glacial transformations are here of enormous volume. It will have to be determined by future studies of the glaciers whether these glacier movements were due to pressure exerted by upstream parts of the glacier ("block and scale movement") after the theory put forth by Pillewizer and other authors [11, 16] or due to a greater plasticity of the bottom strata of the glaciers ("extrusion movement", [1, 15, 19, 21] or "turbulent movement" [5]), remaining under the high pressure of the overlying masses. A block or extrusion movement must have been caused by the numerous steps [16] developed at a larger scale in the High Tatra, and by the larger volume of ice and firn masses derived from both the firn basins and the tributary valleys issuing perpendicularly into the main glacier. This in turn led to the formation of rock basins due to overdeepening and rock bars, to the intensification of steps and to the formation of typical glacial troughs. In the formation of rock basins an important role may also have been played by turbulent movements [5], although this theory also requires further research. In the lower valley sections the progress of the valley glacier was more gradual and, consequently, here the rate of transformations is lower.

In the Western Tatra, the smaller bodies of firn and ice moved at a slower rate, by a laminar movement characterictic of glaciers of scant thickness [16]. Therefore, here rock basins are lacking and the degree of transformation is much smaller.

The geomorphological investigation of the small Tatra Massif which was gradually uplifted and dissected in the Neogene, but later was thrice glaciated during the Pleistocene, leads to the rejection of both extreme theories, the "glacial" [12] as well as the "antiglacial" [18], at the same time supplying arguments in favour of the "transformation" theory. Detailed studies of the Tatra relief led to the recognition of a variegated course and intensity of glacial erosion, due mainly to the preglacial relief. The influence which the preglacial relief must have exerted on glacial erosion and on the rate of transformation, determined by De Martonne [13, 14] at the rise of the present century, has since been confirmed by many scientists (Distel, Lehmann, Lautensach, Burchard, Fels, Klebelsberg, Nussbaum, Ahlmann, Nangeroni, Solch, etc.) and is commonly admitted today. According to the opinion of these authors, the preglacial relief governed the occurrence and the shapes of the glacial troughs, of their shoulders, of some of the glacial cirques and of numerous valley steps. On the other hand, taking the Tatra as example it may be asserted that the preglacial relief bore not only upon the development of these forms, but that it also accounts for both type and magnitude of the glaciations [8], thus for the sizes and thicknesses of the firn fields as well as the lengths and thicknesses of the valley glaciers and, ultimately, for the rate and character of the movement of the masses of firn and ice. And on these latter factors depends the type and the intensity of glacier erosion. On the basis of the relation of the glacial to the preglacial forms it can be assumed that the glacial forms were not developed anew during every successive glaciation (De Martonne, Fig. 7), but that during these periods there only

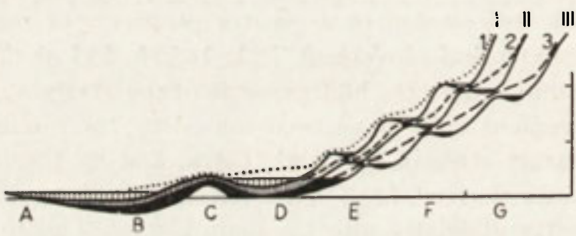

Fig. 7. Evolution of longitudinal profile of glaciated valley, after E. de Martonne

1,2,3, — successive longitudinal profiles of river valley (dash-dotted), I, II, III — successive longitudinal profiles of glacier valley (full line), tied up with profiles of river valleys, A, B, — terminal depressions, C — rock bar, D — overdeepened trough, occupied by lake, E, F, G — rock bars holding up overdeepened lake basins

occurred a superposal of younger glacial forms on top of older glacial forms, little transformed during interglacial, and more intensively altered during ana-and cataglacial periods. This repeated modification of glacial forms led to the evolution of the present-day forms. They are larger, deeper and more typical than were the forms shaped during one glaciation.

The study of the origin and the distribution of glacial cirques clearly indicates that no interrelation exists between the occurrence of these cirques and the snow line. Above the snow line they developed simultaneously at various altitudes, wherever suitable orographical conditions created conditions for the formation of glacial cirques.

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EFFICACY OF INLAND-ICE EROSION IN THE MAŁOPOLSKA UPLAND DURING THE MIDDLE POLISH (RISS) GLACIATION

Kazimierz Klimek

At the time of its maximum extension in Poland the margin of the Riss ice-sheet lay along the northern edge of the Małopolska Upland. In this region the glacial features corresponding with the maximum extension od this ice-sheet are traceable 150-200 km north of those referable to an earlier (Cracovian) glaciation (Fig. 1). To the west (the Sudety Mts., Moravian Gate) and to the east (the southern Ukraine) of the upland the limits of the Riss extended beyond those of the older glaciation.

The extension of the Riss ice-sheet in the Małopolska Upland has been studied and discussed by many geomorphologists [3. 10, 11, 22]. Investigations permit the position of the ice-front to be outlined to prove that both the horizontal and vertical extension of the ice-mass varied significantly in different regions. West of the upland a lobe extended as far south as the Moravian Gate depression (350 m above sea level) in latitude 49°30' N. It is here that the Riss reaches the southernmost limit in Central Europe. East of the Moravian Gate the Riss drift terminates at a line farther north (to latitude 51°40'N) following the northern slopes of the Małopolska Upland and of the Lublin Upland to the east. Farther east the ice-sheet of the Riss extended southward into the Dnieper Plain. It is evident that in the northern foreland of the Małopolska Upland the inland-ice forced its way in lobes or tongues which sometimes extended far south into the upland region. Three lobes named after the principal rivers, the Pilica, Vistula and Bug, and numerous tongues which extended into the small depressions and valley-mouths are traceable in the uplands. The relation between the form of the ice-front and the land-forms shows that the extension of the ice-sheet depended on the height of the buried land-mass. Thus mounds up to 30-60 m high frequently obstructed the passage of ice.

The glacial deposits occur at different levels indicating different heights of the ice-front. Glacial deposits are found on the scarp face of the Central

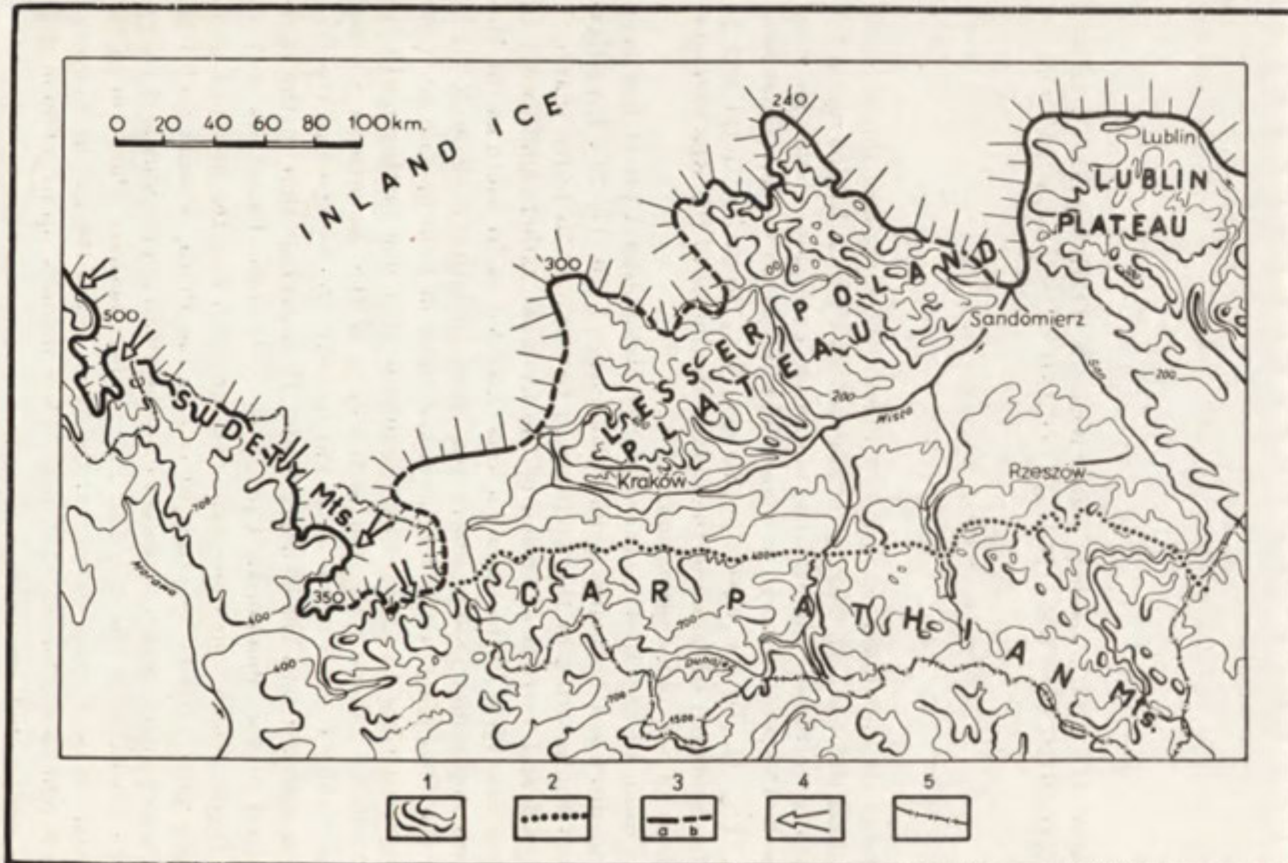

Fig. 1. Extension of the ice-sheet of the Middle Polish (Riss) glaciation in southern Poland

1 — contour lines, 2 — limit of the Cracovian (Mindel) glaciation at the foot of the Carpathians, 3 — limit of the Middle Polish (Riss) glaciation: a — established, b — presumed, 4 — zone of piled up ice-front, 5 — State frontier.

Sudety Mts. at heights up to 500 m a. s. l. [7] in the Moravian Gate at 350 m [24], in the southern part of the Silesian Upland between heights of 260 and 320 m [10], in the northern part of the Silesian Upland at 300 m, in the Pilica depression at 250 m, in the northern foreland of the Świętokrzyskie (Holy Cross) Mts. at 240 m [22], in the Vistula gap between heights of 150 and 200 m [1], on the northern slope of the Lublin Upland at 250 m [5, 6] and in the southern Polesie between heights of 150 and 160 m a. s. l.

Thus the high levels of the piled up ice-margin (560-580 m above sea level in the western Sudety Mts.), lobes extending far south into the Moravian Gate (in latitude 49°30′ N.) and the Dnieper Plain (in latitude 48°40′ N.) and glacitectonic features (in the foreland of the Sudety Mts., in the Moravian Gate) are evident in the neighbouring areas. In the Małopolska Upland, however, the ice sheet did not extend so far south and its margin lay between heights of 250 and 300 m a.s.l. This suggests that in this zone the erosive power of the advancing inland-ice was reduced. The glacial modification of pre-existing landforms and deposits was, therefore, small and is evident in their preservation.

In Tertiary and early Pleistocene times the northern slope of the Małopolska Upland was subjected to different morphogenetic processes active under different climatic conditions. These processes produced a varied relief including different land-forms and deposits. The degree of their preservation gives some indication of glacial modification. It also enables us to compare the glacial modification of the Małopolska Upland with that of other regions. Generally speaking the advancing ice-sheet either filled the depressions whose floors were lying between altitudes of about 150 and 200 m or covered the upland summits. Only a few hills and ridges exceed heights varying between 250 and 300 m a.s.l. The upland ridges for the most part consist of Mesozoic rocks (or locally of Palaeozoic rocks) of different resistance to mechanical destruction (sands, shales, marl, sandstones, limestones, dolomites). No smoothing, grooving or scratching of rock-surfaces indicating glacial erosion has as yet been observed. On the other hand, there occur many land-forms, especially in the northern part of the Cracow-Częstochowa Upland each of which bears the mark of processes effective in Tertiary times. Furthermore, on the flat-topped ridges there are found pre-glacial deposits that survived glacial erosion. Examples of the former are patches of Miocene clayey deposits covering ridges in the southern part of the Silesian Plateau. In the northern part of the Cracow-Częstochowa Upland there occur old karst land-forms (huge sink-holes, fissures widened by solution) filled with Pliocene and early Pleistocene deposits [14, 15, 16]. In some areas accumulations of a terra-rossa-like weathering product cap upland ridges. Decalcified calcareous rocks also occur. These facts indicate that glacial erosion was ineffective on the hills which were particularly amenable to the attack of ice because of thier position. Though Riss glacial deposits contain much locally derived debris (up to 80%) [22], both the distribution of these sediments in relation to the occurrence of parent rock, and the rounding of boulders point to a very short transport not exceeding a few kilometres. The locally derived boulders are rather small (10-50 cm in diameter). Only a few of them are larger than the erratics of Scandinavian origin. The material was removed from the top layer of the mantle of rock-waste which covered the upland summits in pre-glacial times, and not eroded from the solid rock-floor. Furthermore, deeply weathered rocks are found under a cover of boulder clay at numerous points. This suggests that the ice did not erode the rocks over which it passed.

In the extensive depressions which separate the upland ridges the ice-sheet covered the less resistant Quaternary deposits (mainly varved sands, silt and clay). Despite their small resistance to glacial pressure [1] these sediments are lying almost flat. Pronounced pressure effects are rare. Similar undisturbed varved deposits with a sheet of boulder clay above them have been found by W. Pożaryski in the Vistula gap [19], by J. Czarnocki in the surroundings of the Świętokrzyskie Mts. [2], by E. Passendorfer and E. Rühle in the upper Pilica depression [18, 23], by I. Jurkiewiczowa and J. Premik in the drainge basin of the Widawka river [9, 20], by K. Klimek in the northern part of the Silesian Upland [13], and by S. Gilewska and W. Nechay in the southern

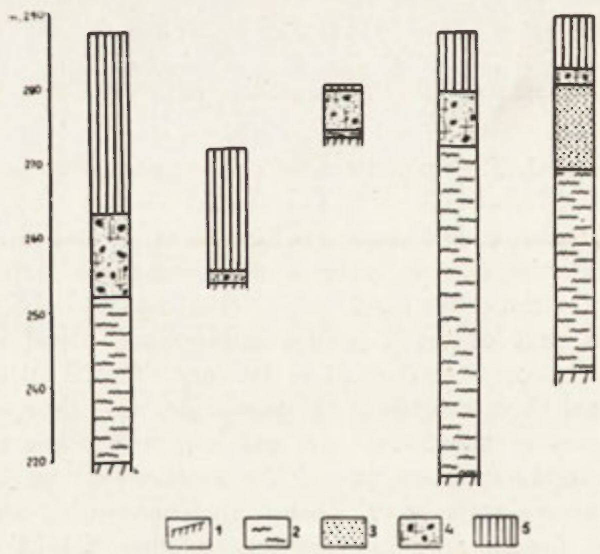

Fig. 2. Sequence of Middle Polish (Riss) deposits in the upper Warta depression.
1 — sub-drift surface, 2-3 — sub-morainic varved deposits (silt and sands), 4 — boulder clay, 5 — deposits laid down during a phase of retreat of the Middle Polish (Riss) ice-sheet

part of the Silesian Upland [4, 17]. Many of these depressions were filled with deposits which yield organic remains dating from the preceding Masovian (Mindel-Riss) interglacial period [9, 18]. Investigations in the northern part of the Silesian Upland [13] reveal the following succession of events during the advance of the Riss ice-sheet. The ice invaded first the depressions and then, as its mass increased, gradually covered the mounds whose tops were only 30-50 m above the depression floors. This mode of advance is indicated by the position of the sub-morainic varved deposits. On the depression floors the accumulation of the lacustrine deposits terminated during an earlier phase of the glaciation. On the sides of the depressions lacustrine sands and silt extend higher up. This strongly suggests their deposition between the margin of the advancing ice-sheet and the ice-free hillside (Fig. 2). Similar relations have been demonstrated by W. Pożaryski [19] in the Vistula gap. It might be suggested that the ice-sheet here covered first the depression floor and then gradually extended over the higher sites giving clear evidence of both considerably reduced glacial pressure and adjustment to the pre-existing landforms. Thus the advancing ice was rather passive and exerted a protective influence on the rocks beneath.

In the light of such facts, the erosive potency of the advancing ice-sheet of the Riss was reduced on the northern slope of the Małopolska Upland and in its immediate foreland and thus differed from that in other regions. These differences were due to the small activity and thinness of the ice-mass in the region discussed.

What was the cause of this phenomenon? It is possible that the form of the buried land-mass accounted for the different efficacy of glacial erosion as already has been suggested by M. Klimaszewski [12].

The sub-drift surface of Poland which is shown in Fig. 3 comprises a distinct elongated dome on the north-west side of the Małopolska Upland. This elongated dome follows the direction of the Pomeranian-Kujawy anticlinorium. On its western and eastern sides there occur depressions down to 100-200 m deep. The elongated dome which trends north-westward might have been responsible for the partition of the advancing ice-mass into two lobes — i.e. the western lobe extending into the depression of the Odra drainage-basin, and the eastern lobe extending into the Masovian synclinorium. The partition of the ice-mass already took place on the shores of the Baltic Sea where the difference between the top of the buried dome (100 m a.s.l.) and the adjacent depression floors (50 m below sea-level) attained its maximum. In the Odra basin the unchecked ice-mass moved rapidly south towards the foot of the Sudety Mts. where it is seen to be piled up to high levels. In this zone the extensive glacial activity accounts for the huge push features that frequently occur between the Sudety Mts. and the limit reached by the last ice-sheet.

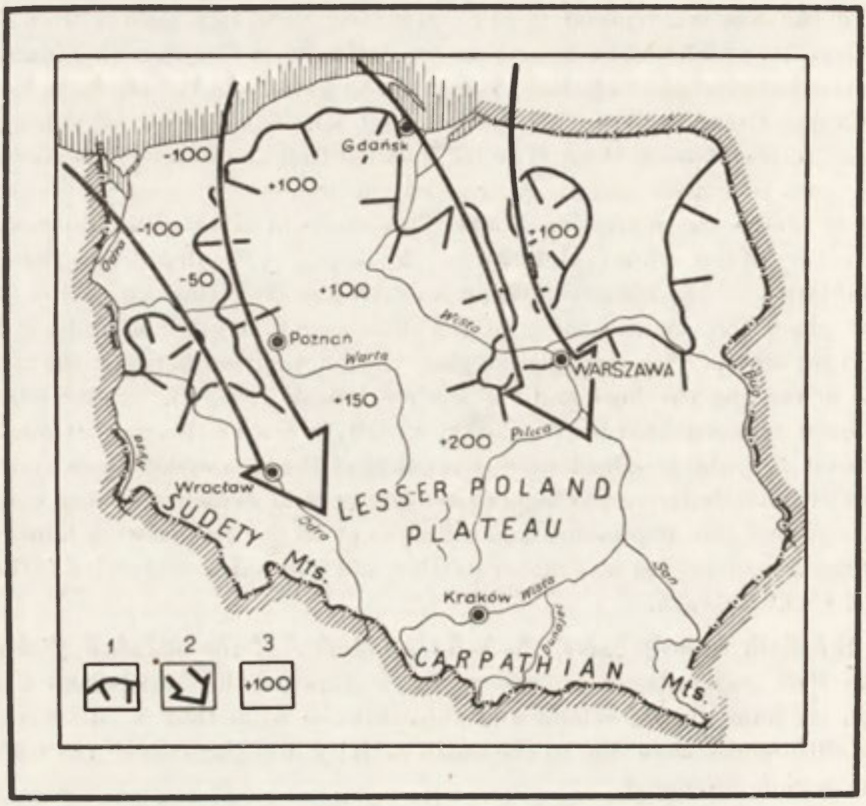

Fig. 3. Influence of the sub-drift surface on the main directions of ice-flow
1 — major buried domes, 2 — main directions of unchecked ice-flow, 3 — altitude of the sub-drift surface in metres

On the top of the Pomeranian-Kujawy anticlinorium the ice-mass, here of no great thickness, moved more slowly. The salient northern foothills of the Świętokrzyskie Mts. obstructed the passage of ice and caused the ice-margin to divide into the accessory Pilica and Vistula lobes as already has been suggested by J. Czarnocki [2]. The existense of an interdependance between the limits of the younger glaciations and the gravimetric anomalies in the European Lowland has also been established by B. Halicki and T. Olczak [25].

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The main cause of small ice-erosion on the northern slope of the Małopolska Upland during the Middle-Polish (Riss) glaciation was the reduced activity of the advancing ice-sheet. This was due to the existence of protruding rock-masses in the sub-drift surface — i.e. the Pomeranian-Kujawy elongated dome which extends far to the north. It may be concluded that the erosion effected by the advancing ice-mass that overrode a great barrier was much smaller that achieved by an ice-mass whose passage was not obstructed by such barriers. The former ice-mass was thinner and probably moved more slowly. On the northern slope of the Małopolska Upland — the sub-drift exerted a great influence on the course and character of glaciation. Thus the local directions of ice-flow, the velocity of movement, and the mode of glaciation of different regions were governed by the buried rock topography.

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GEOGRAPHIA POLONICA 2,1964

ABRASION OF SANDS IN THE STREAMS OF KWISA (SUDETY MTS.) AND BIAŁKA-DUNAJEC (TATRA-CARPATHIANS)

Bogumił Krygowski

Introduction

The mechanical method of determining the morphology of sand grains, the so-called "mechanical graniformametry" [9] is being applied in Poland since 1937 [4]. Gradually improved up to recent times, this method yields progressively better results [5, 7, 9], and it should be stressed that, being carried out speedily, it allows making a great number of analyses — a fact of significance both in scientific research and in practical field work.

Admittedly, grain abrasion as determined by this method based on an inclined plane, is not identical with the rounding of grains established by means of geometrical methods as, for instance, by A. Cailleux [1, 2] or Ph. Kuenen [10]. The reason is that the former method grades grains according to several of their features (sphericity, roundness, dullness), whereas the latter method is rather based on but one feature (roundness). Even so, the graphical images of abrasion of sands from the same stream, determined by the author's mechanical method and by the geometrical methods used by Cailleux and Kuenen are much alike, as shown in Fig. 1, — proof not only of unquestionable analogies but also of the correctness of both methods.

Even more striking is the correlation of the results obtained, on the one hand, by the author's mechanical method [9] and by Khabakov's [13] visual method on the other hand. as shown in Table 1.

Clearly noticeable is the parallel course of index values, expressed by the gradual increase of the index from lowest to highest values; this increase is 3.23- fold with Khabakov's, and 3.6- fold with the author's method.

The results shown above, arrived at in hundreds of separate analyses, prompted the author to apply his method to manifold patterns of sediments as, for instance, the sand deposits found in the rivers mentioned above; this put forth in the next chapter.

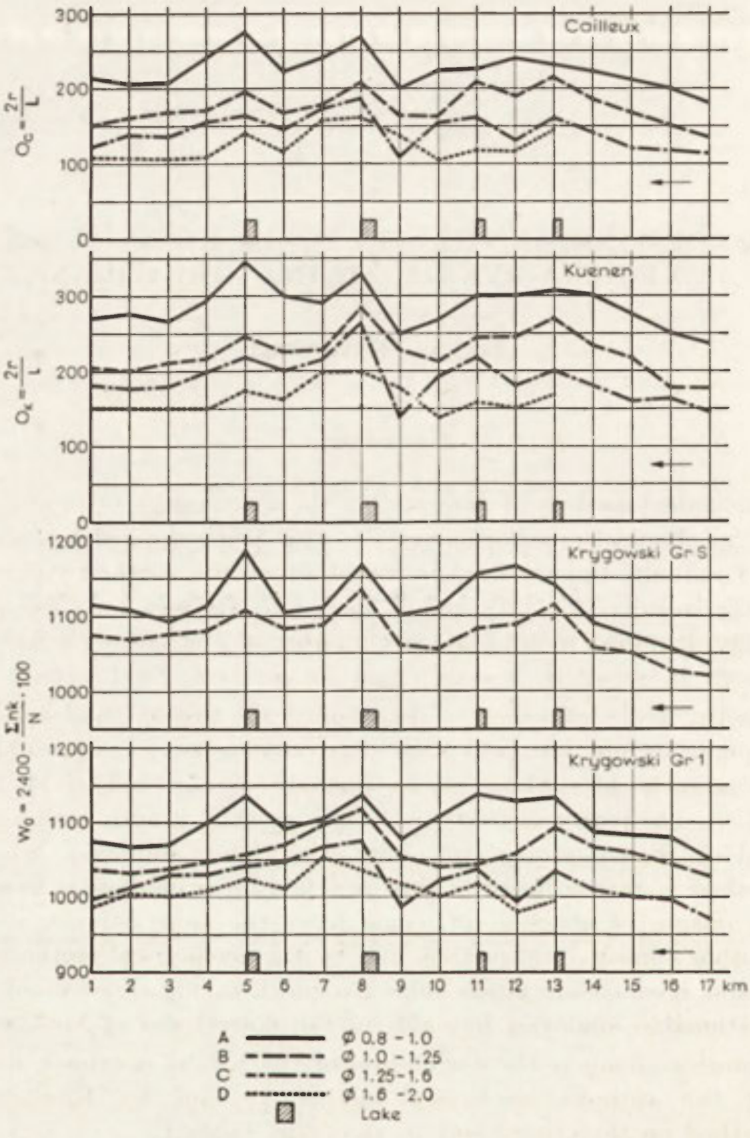

Fig. 1. Curves illustrating degree of roundness or degree of abrasion of sands of Główna creek, a right-hand tributary joining the Warta river at Poznań. The correlation between the graphs obtained by geometrical methods (Cailleux, Kuenen) and by the author's mechanical method is clearly visible

GrS and Gr 1 — different types of graniformameters, ⟶ — direction of river flow, A, B, C, D — grain fractions (curves plotted by E. Kościółek)

TABLE 1. ABRASION INDEX OF SANDS

Abrasion index W_o after the author's theory	Abrasion index after Khabakov	Description of degree of abrasion or roundness
2300	3.81	very thorough roundness
2100	3.54	intermediate degrees of roundness
1900	3.28	
1600	2.55	
1150	1.26	
650	1.18	no roundness

ABRASION CURVES FOR SANDS FROM KWISA AND BIAŁKA-DUNAJEC

Sand and gravel samples were collected in the river channels (Fig. 2) and the degree of abrasion of quartz grains of 1.00-1.25 mm diameter was determined by means of a graniformameter [9][1], applying the formula:

$$W_o = 2400 - \frac{\Sigma(n \cdot k)}{N} \cdot 100$$

where: W_o index of abrasion
n number of grains in angle classes,
k mean angle characterizing a given angle class,
N number of grains in sample examined.

Also determined was a second parameter, the index of dissimilarity $N_m = Q_3 - Q_1$.

The diagrams plotted were based on 82 samples examined of sand from the Kwisa (Fig. 2, II) and on 47 samples from Bialka-Dunajec sand (Fig. 2, III). In view of the fact that both rivers issue from zones of crystalline rocks (granites, gneisses) and subsequently pass zones of sedimentary rocks, it was possible to establish a preliminary differentiation of the following processes: 1) an initial abrasion of "granite" grains in the stream reaches of the crystalline zones, and 2) an intermixing of grains from the crystalline and the sedimentary zones taking place beyond the crystalline zone.

Studying Fig. 3 showing abrasion of Kwisa sands, we readily observe enormous leaps, especially in the curve of the abrasion index W_o. Even so, notwithstanding this chaotic pattern it is evident that, in its general trend grain abrasion rises in a downstream direction, as expressed by the mean values of the W_o index, calculated for successive sections of the river:

	W_o	N_m
for mountain section	834	2.89
for upland section	901	2.46
for lowland section	1070	2.79
for full length of river	940	2.73

[1] An apparatus for grading sand grains according to their degree of abrasion.

The balanced values of the dissimilarity index N_m seem to indicate relatively uniform hydrodynamic conditions in the channel of the Kwisa river.

The rapid increase in roundness (or abrasion) in the upper reaches of a river often determined in other rivers [2, 8, 14, 17], has thus also been confirmed in the case of the Kwisa river.

The causes of the marked rising and falling of the W_o curve appearing within short river sections, are manifold, often rather complex. Let us mention some of them:

1) The tributary streams, carrying into the main stream grains of a different degree of abrasion, are bound to distort, often quite abruptly, the abrasion curve in the main river. This is seen particularly clearly in the initial seven kilometers of this river, with its sharp zigzag turns.

2) "Streams" of granite talus with a marked granular grain pattern, sliding down into the stream channel from adjoining scarps.

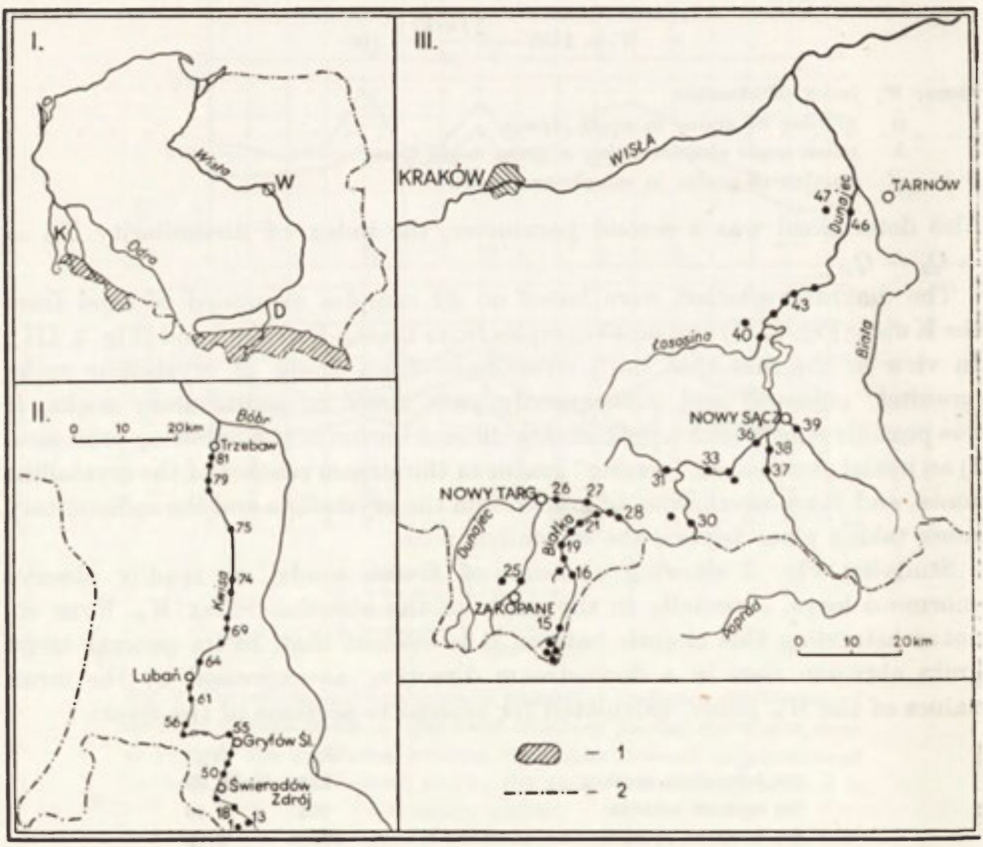

Fig. 2. Maps showing localities of collecting samples

I — general layout of rivers examined. K — Kwisa, D — Bialka-Dunajec, II — localities of collecting samples of Kwisa sand, III — localities of collecting samples of Białka-Dunajec sand, 1 — mountain zone, 2 — frontier line

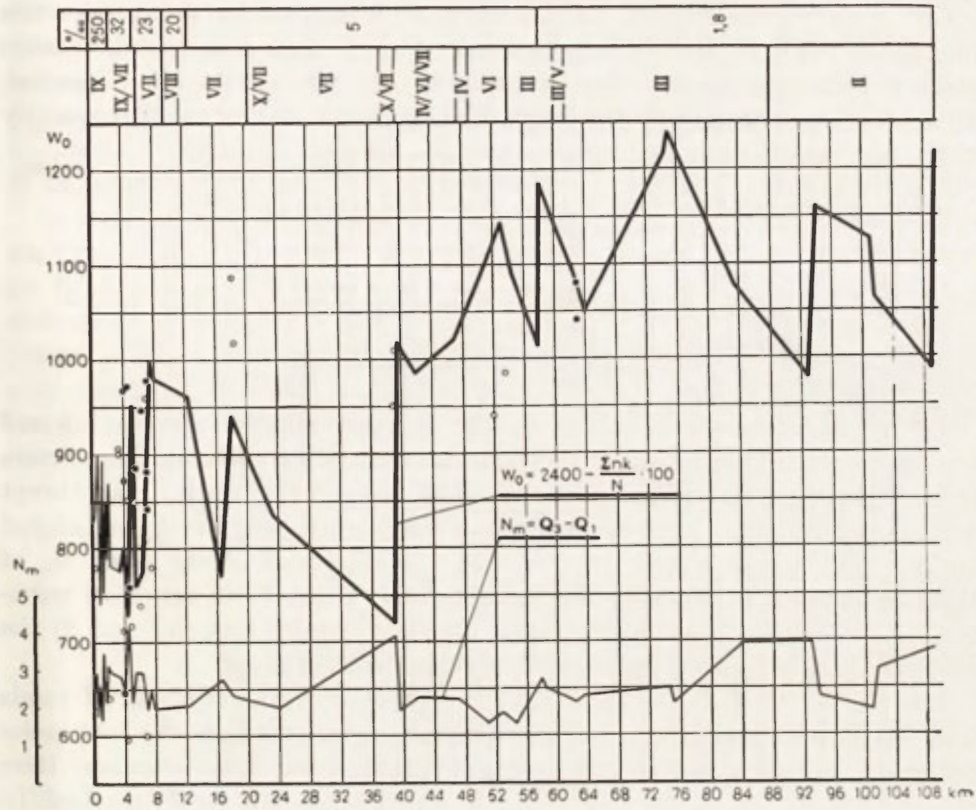

Fig. 3. Curves W_0 (heavy line) and N_m (thin line) for quartz grains of 1.00–1.25 mm dia. of Kwisa sand. Generally speaking, the curve of grain abrasion (W_0) rises in a downstream direction (the degree of abrasion grows) showing marked breaks. The course of the N_m curve is rather balanced. Lithological zones indicated at top of figure: II — alluvial cones, III — Pleistocene sands and clays, IV — loesses, V — Mesozoic sandstones, VI — Palaeozoic shale, conglomerates and greywacke rocks, VII — Iser gneisses, Rumbov granite, VIII — micaceous schists, quartz schists, and other rocks, IX — Karkonosze granite, X — Tertiary basalts. On left side of graph: values of indices W_o and N_m. White circles — right-hand tributaries, black circles — left-hand tributaries. ‰ — river gradient

3) The differentiation of lithological zones passed by the river. The conspicuous increase in grain abrasion, noticeable after the Kwisa enters the zone of Pleistocene deposits known by their strongly rounded grain [6], indicates the significance of the lithological factor.

4) The river gradient. In rapids and waterfalls, grain disintegration by splitting is very intensive, causing a lowering of the value of W_o. Proof were measurements made at waterfalls of the Kamienna river in the Sudety Mts. undertaken in 1962 by A. Kostrzewski (Table 2).

All the data mentioned above show that the W_o curve for Kwisa sands is a function of a number of agents.

Only partly justified seems to be the belief expressed by many scientists [3, 12, 14, 17] that, after strong abrasion in upper river reaches, there takes place a slower but continuous abrasion in the subsequent lower reaches. This probably explains why the diagrams of abrasion of river sands frequently differ very much from the abrasion pattern inferred formerly.

TABLE 2. ABRASION INDEX W_o ON THE KAMIENNA RIVER

Waterfall No.	W_o value of sand grains measured	
	above the fall	below the fall
I	1214	866
II	1036	988

The W_o curve for the Kwisa sands also deviates notably from the inferred typical pattern. This deviation shows, in a downstream direction, for certain river sections not an increase in the W_o value but, on the contrary, an abrupt decrease of W_o. This peculiar inversion, which years ago has been pointed out by Russell and Taylor [15] in their investigations of the rounding of Mississippi sands, is probably chiefly caused by: 1) the joint action of tributaries (a factor not sufficiently taken into account by Russell), and 2) the alternate part played by processes of abrasion and selection.

The second diagram shown (Fig. 4), illustrating grain abrasion of sands from the Bialka-Dunajec river, also presents some data on the intricacies occurring in the abrasion process of sediments carried by streams. Here also the deviation from the ideal curve discussed above is strongly marked. To start with, we observe an abrupt rise in the value of the W_o index (extending over the first 40 km section), followed by a notable decrease of this value (in the 40 to 162 km section) and, again, a substantial increase. Whereas the initial intensive abrasion can easily be explained by the effect of wear on the sharp edges and corners of the angular sand grains during rapid headwater flow, the interpretation of the marked inversion in the abrasion index within the middle course of the river is difficult.

The abrupt decrease in the value of the W_o index after the inflow of the Bialka into the Dunajec river (which latter river carries sand of markedly angular shape, its W_o being 724) seems to indicate that it is the Dunajec river that causes this peculiar inversion in the course of the abrasion curve for Bialka-Dunajec sand. In view of the fact that the sands of the upper Dunajec reaches (in the Tatra section) show, similarly as the Bialka sands, first an abrupt rise and afterwards a decrease in the W_o index, it seems justified to suppose that, following the initial phase of intensive grain abrasion in the upper river reaches, a splitting of sand grains gradually dominates in further river sections, causing the inversion observed. The subsequent gradual downstream rise of the W_o curve within the inversion section may, perhaps, be explained by the splitting of grains coming to an end with the gradual flattening of the river gradient, so that abrasion again becomes the dominant factor.

As may be seen in Fig. 4, the sand grains of Flysch sediments, carried into the Dunajec channel by tributaries from the Flysch zone, affect the pattern of abrasion of the Bialka-Dunajec sands only to an insignificant degree.

As regards the renewed intensive increase in the W_o value observed downstream from km 162, it seems to be brought about by at least several factors, such as: 1) abrasion, 2) selection, and 3) participation of more abraded sands from sediments of the Silesian Nappe pierced by the river. The high W_o value (1107) of the sands of one of the "Flysch tributaries" seems to confirm this assumption. The Pleistocene sands of the lower reaches of the Dunajec river, being intensely abraded, may also contribute to raising the value of W_o of the Bialka-Dunajec sands in this part of the river. Furthermore, here in the

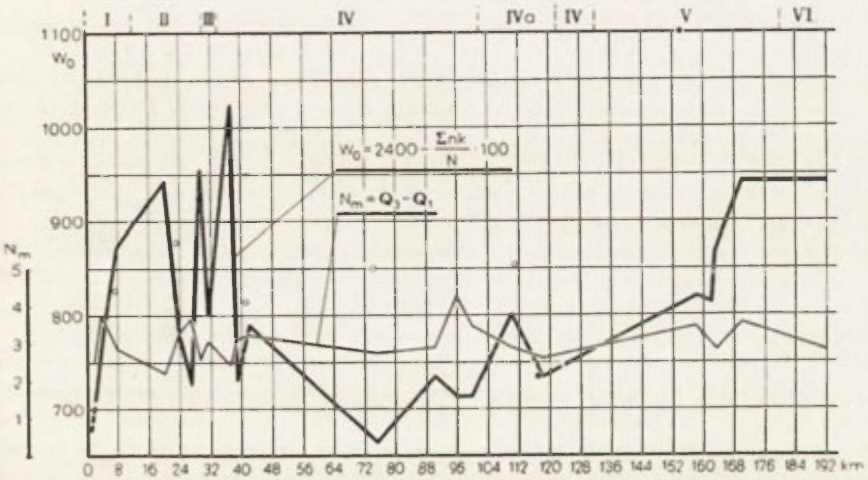

Fig. 4. Curves W_0 (heavy line) and N_m (thin line) for quartz grains of 1.00–1.25 mm dia. of Bialka–Dunajec sands. White circles — right–hand tributaries, black circles — left–hand tributaries. On left side of graph: values of index W_o and of dissimilarity index N_m. Lithological zones indicated on top of figure: I — Tatra granites, II — Podhale Flysch, III — Pieniny Klippen Belt, IV — Magura Nappe, IVa — Pliocene, V — Silesian Nappe, VI — Miocene

lessened slope of the river channel, abrasion is probably rather replaced by selection. It seems to be a fact that a stream of reduced energy takes hold of and carries off rather the angular grains, leaving the more abraded and rounded sand grains. This viewpoint has been expressed by various authors investigating other rivers [6, 11, 13].

*

From the reflections presented above it appears that the pattern of abrasion of sands and gravels of rivers is a function of many factors, often mentioned and described but never actually measured. It may be that the new method discussed (mechanical graniformametry), yielding analyses plentifully and rapidly, will make exact measurements possible in the near future.

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GEOGRAPHIA POLONICA 2,1964

CONDITIONS D'ACCUMULATION DU LOESS DANS LA PARTIE ORIENTALE DE L'EUROPE CENTRALE

Henryk Maruszczak

1. Introduction

En 1951, J. Büdel a distingué deux zones d'accumulation du loess en Europe durant la dernière glaciation: 1) la toundra (zone périglaciaire) et 2) la steppe et la steppe-forêt (zone tempérée). Dans la partie orientale de l'Europe centrale elles étaient séparées, selon cet auteur, par la chaîne des Carpathes [2]. Les études les plus récentes faites par des auteurs hongrois permettent cependant de suggérer que la ligne de partage courait plus au sud [18]. On peut estimer que le bassin du Danube central formait une vaste zone de transition. Les conditions typiques du domaine périglaciarie régnaient sans aucun doute dans le bassin de la Vistule tandis que le Danube inférieur avait celles du climat tempéré. Il faut noter toutefois que les auteurs roumains sont enclins à voir des traces de phénomènes périglaciaires même dans cette dernière région [16]. Sur la base d'observations personnelles j'estime cependant que les cryoturbations décrites, en provenance des plaines riveraines du bas Danube, présentent des traces de gel saisonnier et non de gel perpétuel.

Dans ce qui suit nous nous occuperons donc uniquement de l'analyse des terrains loessiques des bassins de la Vistule et du Danube inférieur. Notre propos est de déterminer, d'une manière plus détaillée, les conditions dynamiques de l'accumulation du loess. Les conditions géographiques ont été en effet définies de manière générale par l'affirmation de l'appartenance de ces régions aux deux zones de climat mentionnées. Remarquons que les loess des territoires étudiés sont comparables puisqu'ils proviennent principalement de la dernière glaciation. Ceux de périodes glaciaires plus anciennes sont en règle générale ensevelis sous ces derniers et n'apparaissent qu'en quantités nettement inférieures.

2. Conditions d'accumulation du loess dans la zone périglaciaire

En Pologne, la poussière loessique ne provenait pas seulement des dépôts fins du substratum. Elle était aussi partout et continuellement produite, durant la glaciation, par gélivation de matériaux à grains plus gros, comme le prouve la granulation des formations périglaciaires de couverture, communément rencontrées [3, 4, 6]. L'accumulation de grandes quantités de poussière en couches de loess d'une épaisseur dépassant quelques mètres s'est produite, de nombreux faits en témoignent, principalement sous l'action des vents.

Les loess apparaissent en Pologne presque exclusivement sur les plateaux et l'avant-mont carpathique, au relief fortement accidenté. Elles forment une napp couvrant les divers éléments du relief, des terrasses des vallées aux lignes d'interfluve. Ce n'est pas une nappe continue, cohérente mais plutôt des plaques isolées, distinctes, qui, très souvent du reste, traversent les grandes vallées (Fig. 1). De nombreuses données témoignent que ce sont là les caractères primitifs de la répartition de ces formations. Les processus de destruction, en effet, n'ont pas modifié fonciérement l'extension des loess après l'achèvement de leur accumulation [10]. Voilà pourquoi les faits avancés indiquent que le rôle principal dans cette accumulation a été joué par le transport éolien qui s'est fait, conformément à la conception de A. Malicki [9], à de petites distances et dans les basses couches de l'atmosphère. A l'appui de cette thèse, on peut attirer l'attention sur la ressemblance minéralogique et du degré d'usure des grains de sable se rencontrant dans les loess et dans la couche sous-jacente (Tableau 1). Dans le cas de prédominance du transport à grande distance il n'y aurait pas de ressemblance aussi marquée et la répartition des loess serait plus uniforme.

TABLEAU 1 COMPOSITION MINÉRALOGIQUÉ ET DEGRÉ D'USURE DES GRAINS DE SABLE DE FRACTION 0,25—0,1 mm, DES ÉCHANTILLONS PRÉLEVÉS DANS LA COUVERTURE LOESSIQUE ET DANS LES ALLUVIONS SOUS-JACENTES, DANS LA VALLÉE DE LA BYSTRZYCA (LUBLIN) ET DANS CELLE DE COLENTIN (BUCAREST).

Localité (zone d' accumulation du loess)	Echantillon prélevé, de prof. (en métres)	Genre de formation	Composition minéralogique en %%				Proportion de grains en %%		
			quartz	feldspath	carbonates (calc.)	autres mineraux	usés	émoussés	anguleux
Lublin (zone périglaciaire)	2,0	loess	96,2	1,8	1,3	0,7	18,5	66,0	15,5
	8,0	loess sableux	96,1	2,5	1,0	0,4	30,0	49,0	21,0
	10,6	sable fluviatile	98,3	1,5	0,2	—	20,5	60,5	19,0
Bucarest (zone tempérée)	2,0	loess au-dessus du sol fossile	90,7	1,3	3,0	5,0	0,8	29,3	69,9
	4,0	loess sous le sol fossile	51,3	0,4	19,3	29,0	4,3	42,1	53,6
	6,0	sable fluviatile	75,0	4,4	—	20,6	0,3	26,7	73,0

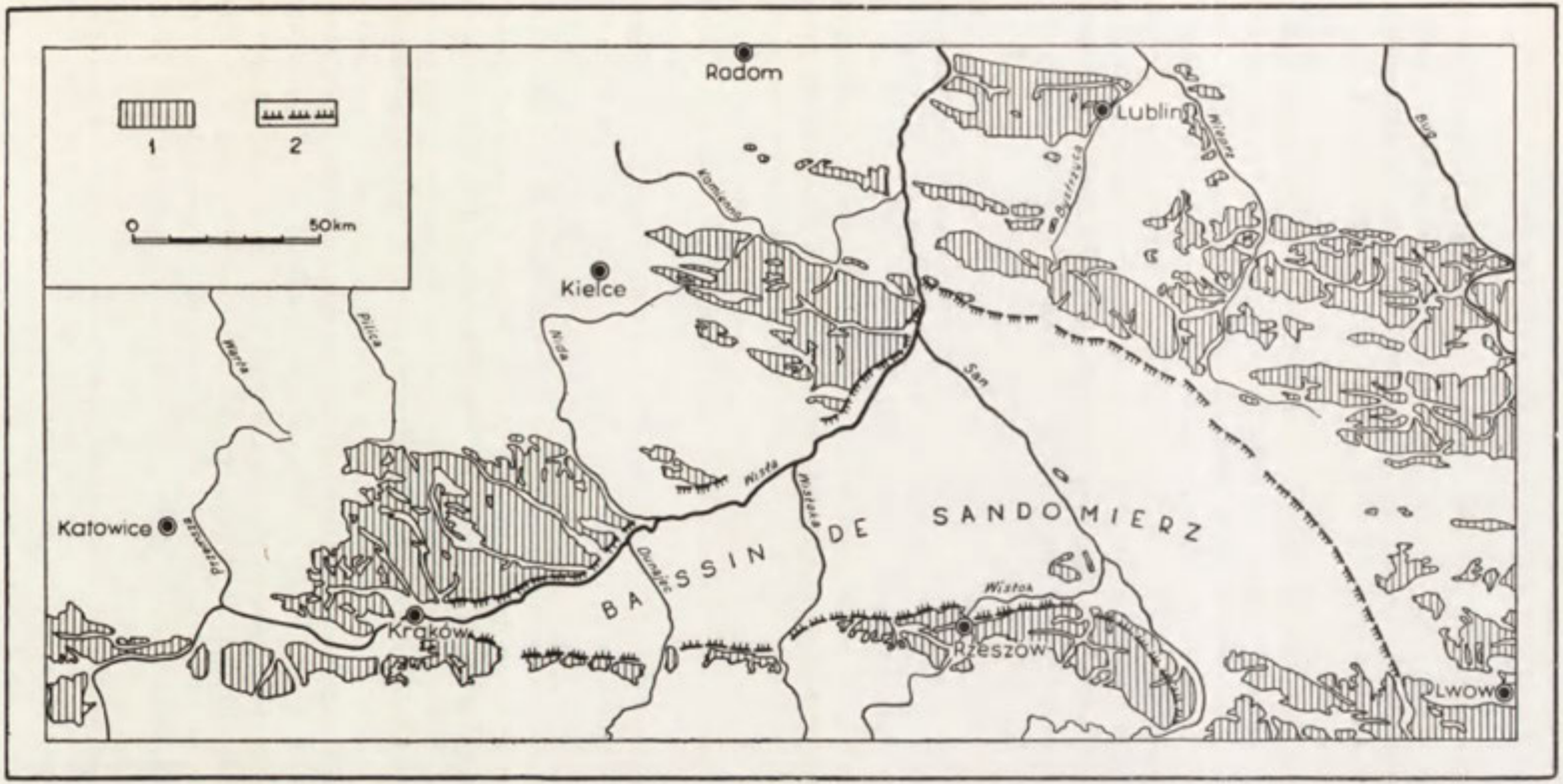

Fig. 1. Repartition des loess dans le bassin de la Vistule en Pologne. Terrains couverts de loess donnés d'après l'Atlas Géologique de la Pologne [1] avec d'insignifiants corrections par l'auteur du présent article

1 — terrains couverts par le loess et les dépôts loessoïdes; 2 — escarpements nets des plateaux et de l'avant-mont carpathique à l'entour du Bassin de Sandomierz

L'analyse de la répartition des loess en Pologne fournit une base pour la détermination de la force et de la direction des vents transportants. De ce point de vue l'absence de loess sur la surface plane du Bassin de Sandomierz entouré de plateaux "loessiquess" (Fig. 1), est très significative. L'on ne saurait expliquer le fait par une insuffisance de poussière, ne serait-ce que pour la raison que l'éclatement des roches par gel agissait avec la même énergie à l'intérieur du Bassin que sur ses rebords. On ne peut non plus affirmer que c'est un phénomène secondaire, causé par la destruction du loess, car les forces destructrices sont plus intenses sur les plateaux. Il faut donc accepter qu'en plaine régnaient des conditions dynamiques défavorables à l'accumulation du loess. La plus logique semble être la thèse que dans les plaines les vents étaient suffisamment forts pour déplacer continuellement la poussière d'un endroit à l'autre. Elle n s'accumulait en quantité un peu importante que là ou les vents faiblissaient, rencontrant des terrains plus élevés et au relief plus fort. A titre d'appui ajoutons qu'à présent la moyenne annuelle de la vitesse des vents à l'intérieur du Bassin de Sandomierz est généralement de 3,0 à 3,5 m/sec, alors qu'elle n'est que de 2,8 m/sec environ sur les plateaux alentour[1].

La relation établie entre l'absence de loess dans le Bassin de Sandomierz et la vitesse du vent fournit une base pour déterminer la direction du transport éolien de la poussière. Le Bassin est enclos par les escarpements nets, hauts de 100 m et plus, des plateaux et de l'avant-mont carpathique environnants. Les escarpements du côté N.–O. et S. sont couverts de loess, celui du côté N.–E. en manque complètement. Les bords des plaques loessiques s'éloignent de ce dernier de 5 à 15 km vers l'intérieur du plateau. Cela permet d'avancer que la poussière était transportée principalement par les vents de l'Est. Les escarpements au vent, c'est-à-dire ceux du côté N.–O. et S. constituaient des obstacles orographiques causant une réduction de la vitesse des vents et de l'accumulation de la poussière atmosphérique qui l'accompagnait.

La conclusion touchant la direction du transport de la poussière est confirmée par l'analyse de la répartition des grains de sable dans les profils loessiques. Sur le Plateau de Lublin cette addition, en forme de grains disséminés ou d'intercalations nettes de sable fin, se manifeste le plus du côté oriental des nappes de loess particulières. Il convient de marquer que ceci a lieu presque exclusivement dans les parties inférieure et médiane de la couverture loessique de la dernière époque glaciaire. Sur le côté ouest, par contre, la quantité de sable, du reste nettement inférieure, apparaît avant tout à la partie supérieure de cette couverture. Il s'en suit que les vents de l'Est dominaient dans les phases initiale et principale d'accumulation du loess, coïn-

[1] Il est intéressant de noter que B.A. Fedorovic, spécialiste connu des déserts asiatiques, a constaté que la poussière loessique ne s'accumule en Asie que dans les terrains où la vitesse moyenne annuelle des vents ne dépasse pas 2—3 m/sec [5].

cidant avec le maximum de la glaciation. Dans la phase terminale par contre les vents d'Ouest prirent le dessus. Ils dominaient déjà nettement lorsque, une fois achevée l'accumulation du loess, se formaient les dunes au tardiglaciaire et au début du post glaciaire [12]. Ainsi donc les couches les plus jeunes de loess se sont déposées à l'époque où la dynamique de l'atmosphère avait des caractéristiques semblables aux présentes.

3. Conditions d'accumulation du loess dans la zone tempérée

Sur le bas Danube les sources de la poussière loessique ont dû être différentes de celle des bords de la Vistule. En effet, la production de poussière par altération cryergique n'a pas joué ici sur une grande échelle. Malgré cela les loess recouvrent des étendues plus vastes et forment des couches plus compactes et plus épaisses qu'en Pologne (Fig. 1 et 2). L'épaisseur de la couverture sur les bords du Danube atteint localement 80 à 90 m, alors qu'elle ne dépasse pas 30 m dans le bassin de la Vistule. C'est pourquoi il faut admettre que la poussière de loess dans la partie danubienne de la zone tempérée est d'une autre provenance que celle de la zone périglaciaire. Au début, avant qu'eût été créé un manteau assez étanche des premières couches de loess, la poussière pouvait être transportée sur une assez large échelle à partit des sédiments tertiaires sous-jacents, argiles d'origine marine ou lacustre. Par la suite cependant, il devait provenir avant tout d'en dehors de l'aire des plaines loessiques actuelles, comme en témoigne la répartition du loess.

La vallée du Danube forme l'axe du territoire couvert de loess (Fig. 2). L'épaisseur du loess est la plus grande sur les berges mêmes de la vallée et atteint 90 m dans les grandes "bosses loessiques" de la haute rive bulgare [7, 8, 13, 14]. A mesure qu'on s'éloigne de la vallée en direction N. et S., la couverture de loess s'amincit — en périphérie son épaisseur est à peine de l'ordre de quelques mètres. Cela témoigne de la connexion entre les loess et la grande artère fluviale qu'est le Danube. En faveur de cette thèse s'ajoute encore le fait de la diminution de grain en aval du fleuve, constatée dans les loess bulgares [7], ainsi que l'épaisseur croissante des loess roumains dans la même direction [17]. L'addition des grains de sable diminue aussi rapidement à mesure qu'on s'éloigne du fleuve perpendiculairement à son cours [7, 8, 14]. Aussi faut-il admettre la conception de D. Jaranoff que la poussière de loess provient des alluvions danubiennes [7]. Une preuve en est aussi fournie par l'affinité entre les loess roumains et les alluvions des tributaires du Danube (Tableau 1). Du reste, la poussière alluviale provenait certainement avant tout d'en dehors des plaines danubiennes. Les auteurs roumains voient l'aire de sa production à l'étage périglaciaire des montagnes du pourtour [16].

Le transport et l'accumulation d'alluvions par le Danube et ses affluents n'explique pas cependant le pourquoi de l'existence d'épais gisements de loess

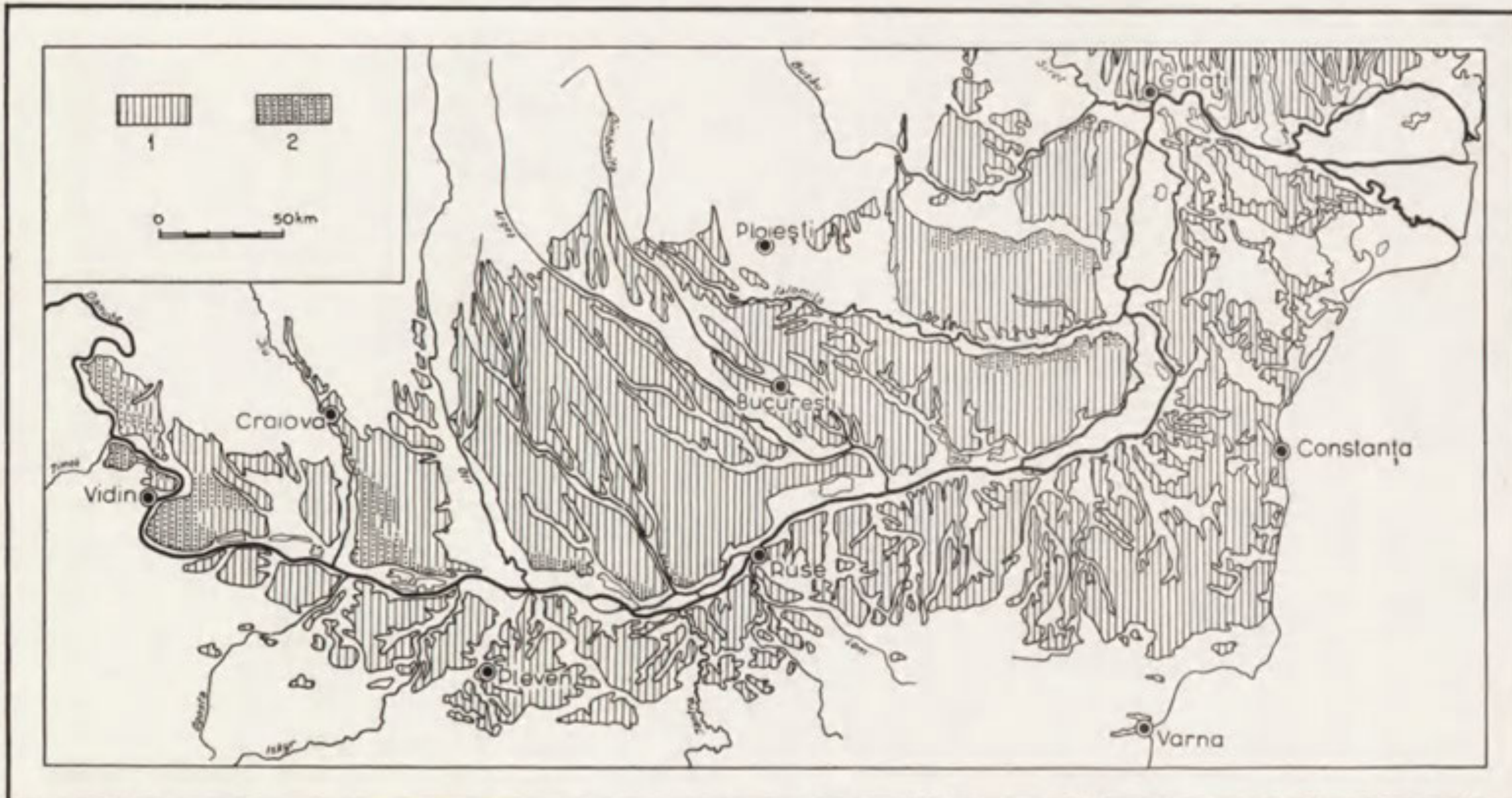

Fig. 2. Repartition des loess dans les plaines du bas Danube. Terrains couverts de loess donnés d' après la carte géologique de la Roumanie [15 annexe VI] et par celle de la formation loessique en Bulgarie septentrionale, élaborée par D. Jaranoff [7].
1 — terrains couverts par le loess et les dépôts loessoides; 2 — sables dunaires sur la couverture loessique.

sur les vastes plateaux entre les vallées, dominant de haut les terrasses fluviales les plus élevées Ils n'ont pu se former que sous l'action éolienne transportant la poussière du fond des vallées. Comme en Pologne ce devait être un transport dans les basses couches de l'atmosphère et à petite distance. Cela est indiqué entre autres par: a) la relation étroite dans l'espace entre les loess et la vallée du Danube, b) l'affinité minéralogique des loess avec les alluvions, enfin c) les faibles différences dans le degré d'usure des fractions de sable dans les loess et dans les alluvions (Tableau 1).

Les loess danubiens couvrent principalement la surface unie de la vaste Plaine Roumaine et, pour une moindre part, les plateaux et l'avant-mont environnants. Ce fait permet de suggérer que la force des vents accumulant la poussière de loess était plus faible ici que sur la Vistule. Grâce à cela, la poussière pouvait se déposer sur les surfaces plats, au voisinage immédiat de la grande aire d'alimentation qu'était le fond de la vallée du Danube. Il est intéressant de noter qu'à l'heure actuelle les vents des plaines riveraines du Danube sont aussi bien plus faibles que dans le Bassin de Sandomierz. Leur vitesse moyenne annuelle ne s'élève en effet qu'à 2 m/sec environ. Ces conditions dynamiques et la grande étendue des plaines danubiennes ont permis la formation d'une nappe loessique nettement plus compacte et moins parcellée qu'en Pologne.

D. Jaranoff admet, s'appuyant sur le fait de la réduction progressive de l'épaisseur des loess bulgares à mesure qu'on s'écarte du Danube vers le Sud, que la poussière était transportée par les vents soufflant des secteurs Nord. Si nous nous basions sur de telles prémisses, il faudrait accepter aussi l'existence de vents du Sud pour les loess situés de l'autre côté du fleuve. L'amincissement de la couche de loess sur les deux rives du Danube suggére donc plutôt que la poussière était transportée par des vents plus ou moins parallèles au cours du fleuve. Dans la partie occidentale des plaines danubiennes dominaient les vents de l'Ouest, comme en témoignent: a) la réduction de l'épaisseur dans le sens Ouest-Est des loess situés entre les affluents de droite du Danube [14], b) l'absence de loess sur le coté Ouest des secteurs méridiens des rivières Jiu et Olt ainsi que du Danube entre Turnu Severin et Vidin (Fig. 2). Dans la partie orientale par contre, dominaient les vents du Nord et du N.–E., comme l'indique l'amincissement dans le sens N.–E. — S.–O., des plaques loessiques s'étendant entre les vallées, orientées dans le sens des parallèles, des affluents de gauche du Danube.

Un système de vents dominants, semblable à celui qui a été suggéré pour la période d'accumulation du loess existait aussi à l'époque où se formaient les dunes "empiétant" sur la couverture loessique. Le modelé des dunes et leur répartition l'indiquent clairement [12, 17]. Actuellement d'ailleurs, ce sont les mêmes vents qui prédominent. Pour les plaines danubiennes, et contrairement à ce qui a lieu pour celles riveraines de la Vistule, nous pouvons donc noter la constance du système dynamique de l'atmosphère de la dernière glaciation à l'époque contemporaine.

4. Conclusions

1) Dans la zone périglaciaire, en Pologne, il y a eu diverses sources de la poussière de loess, parmi lesquelles un rôle important a été joué par les produits d'altération. En conséquence, les aires d'alimentation étaient dispersées. Dans la zone tempérée, par contre, la source dominante de la poussière était constituée par les alluvions du Danube; il s'en suit que l'aire d'alimentation était plus compacte dans l'espace.

2) La poussière de loess était accumulée dans les deux zones principalement par transport éolien, à petite distance et dans les basses couches de l'atmosphère.

3) Les vents transportant le loess étaient plus forts en Pologne que sur le Danube inférieur. Voilà pourquoi, dans le bassin de la Vistule, la poussière atmosphérique s'accumulait en quantités importantes là où les vents rencontraient des obstacles orographiques sous forme de terrains plus élevés et de relief plus marqué. Autre conséquence, le loess était souvent accumulé en plaques, nettement isolées, allongées dans le sens des vents dominants. Le long du Danube, des vents plus faibles déposaient la poussière surtout sur les vastes plaines, au voisinage immédiat des aires d'alimentation, grâce à quoi une couverture loessique plus compacte a pu s'y former.

4) Les vents transportant le loess avaient des directions différentes dans les deux zones. Dans la zone périglaciaire, la majeure partie du loess accumulé l'a été à l'époque où dominaient les vents de l'Est, qui caractérisaient la circulation atmosphérique durant le maximum de la glaciation. L'accumulation ne s'est achevée cependant qu'à l'époque où commencaient à prédominer les vents de l'Ouest, caractéristiques de la circulation postglaciaire (interglaciaire). Dans la zone tempérée, sur le Danube, les vents avaient une direction analogue à l'actuelle, c'est-à-dire qu'aucune modification importante ne s'est produite dans cette région sous le rapport de la circulation atmosphérique depuis le temps de l'accumulation du loess.

Les faits mentionnés témoignent d'une différence marquée entre les conditions dynamiques de l'accumulation éolienne du loess dans les terrains comparés.

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A MATHEMATICAL METHOD OF CORRELATING PLAIN LEVELS WITH RYTHMS IN CORRELATIVE DEPOSITS

Leszek Pernarowski

1. In zones with scarps and sills produced by foldings and faults we note on the one side traces of former erosive horizons, while on the other we penetrate, by bore holes sunk in correlative deposits, fossil horizons of accumulation. The lack of a direct contact between both these horizons presents the problem of correlating them.

2. This problem is closely connected with the problem of the change in the altitude of the lithosphere surface caused by tectonics, accumulative and erosive processes. The simplest solution of this problem is a diagram of the altitude of a point of the lithosphere considered as a function of time in the

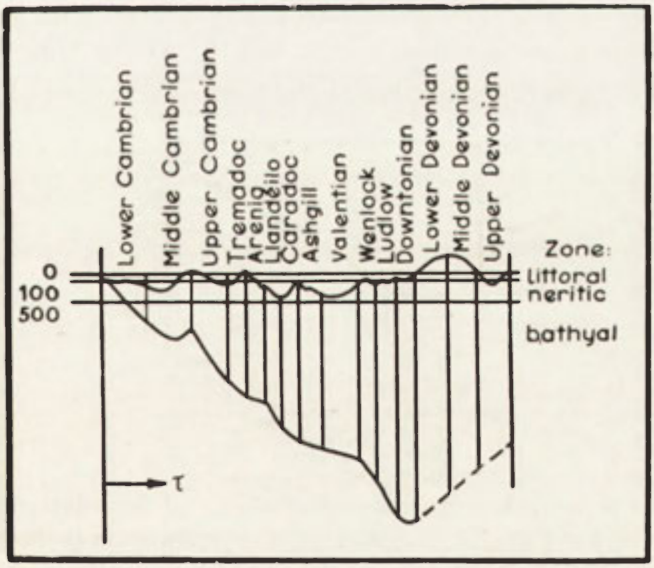

Fig. 1. Palaeogeographical curve (above) and tectonic curve (below) for North Wales (after S. v. Bubnoff)

shape of a palaeogeographical curve, whereas the function of the tectonic movements is shown in the shape of a tectonic curve [2, 3, 5, 6, 7, 10].

Fig. 1 presents the palaeogeographical and the tectonic curve for North Wales in the Older Palaeozoic. We define by symbols so that:

z the altitute of a point of palaeogeographical curve,
z_t the altitute of a point of the tectonic curve,
z_o the initial altitude of the lithosphere, common to the start of both curves,
T the vertical amplitute of the tectonic movement,
A the thickness of the accumulation layer,
E the vertical magnitute of erosion.

From Fig. 1 we read that at any moment of time:

$$z_t = z_0 - T = z_0 + (-T) = z_0 + T \tag{1}$$

$$z - z_t = A - E \tag{2}$$

Entering Equation 1 into Equation 2 we ultimately obtain

$$z = z_0 + T + A - E \tag{3}$$

This is the general equation of the palaeogeographical curve.

3. Fig. 2 presents the area which — in the part marked by the plus sign — is subject to a positive tectonic movement, whereas in the part marked by the minus sign it is subject to a negative tectonic movement. The broken line represents the boundary between these two parts with oposite tectonic tendencies. A river passing through this area, together with its hydrographical network, represents one common morphological level showing the following features: 1) it is contemporaneous; 2) it is continuous; 3) it represents the

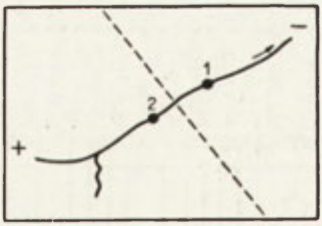

Fig. 2. Distribution of points within area of opposite tectonic tendencies

lowest base for present-day processes of erosion and denudation. This level — which I call the level of the hydrographical system — is in the area covered by a positive tectonic movement a level of erosion, in the area with a negative tectonic movement a level of accumulation.

The equation of the palaeogeographical curve for Point 1 (see Fig. 2) located in the level of accumulation of the hydrographical system, has on the basis of Equation 3 the form:

$$z_1 = z_{01} - T_1 + A_1 \tag{4}$$

whereas for Point 2 situated in the eroded level the equation is

$$z_2 = z_{02} + T_2 - E_2 \tag{5}$$

The current difference in the altitude of these two points is:

$$\Delta z = z_2 - z_1 \tag{6}$$

Entering into Equation 6 the values of z_1 and z_2 taken from Equations 4 and 5 and assuming $T_2 + T_1 = T$ and $z_{02} - z_{01} = \Delta z$, we obtain

$$T = A + E + \Delta z - \Delta z_0 \tag{7}$$

This last equation is also valid in the case of phased tectonic movements. Then, after each $(n - 1)$ and n phase we obtain the equations:

$$T_{n-1} = A_{n-1} + E_{n-1} + \Delta z_{n-1} - \Delta z_0 \tag{8}$$
$$T_n = A_n + E_n + \Delta z_n - \Delta z_0$$

Subtracting the respective sides of these equations and assuming that

$$T_n - T_{n-1} = \Delta T_n; \quad A_n - A_{n-1} = \Delta A_n; \quad \text{and} \quad E_n - E_{n-1} = \Delta E_n \tag{9}$$

and assuming additionally, that in view of the constant tendency to make the grade of the river Δz_n equal to Δz_{n-1}, we may claim that

$$\Delta T_n = \Delta A_n + \Delta E_n \tag{10}$$

In Equation 10, the term ΔT_n is the amplitude of only one phase of the uplift, ΔA_n is the thickness of the rhythm of the correlative sediments, and ΔE_n the magnitude of the phasal erosive dissection.

$$\text{Since} \quad T_n = \sum_1^n \Delta T_n; \quad A_n = \sum_1^n \Delta A_n; \quad E_n = \sum_1^n \Delta E_n \tag{11}$$

we may change Equation 7 to assume the form:

$$\sum_1^n \Delta T_n = \sum_1^n \Delta A_n + \sum_1^n \Delta E_n + \Delta z_n - \Delta z_0 \tag{12}$$

Equations 7 to 12, especially Equations 7, 8, 10 and 12, present in a mathematical form the conditions of the continuity of levels of the hydrographical system at the boundary between areas of different tendencies of tectonic movements.

4. Let us imagine that in an almost level peneplain a tectonic sill developed. In the upper wing a valley is formed whose volume V_d may be defined by the formula

$$V_d = a \cdot P_d \cdot E, \tag{13}$$

where P_d is the surface of this form defined by its upper edges, and where E is the depth of the incision measured at its mouth, and where a is a coefficient depending on the valley's transverse section.

At the mouth of the valley, in the area of the lower wing, an alluvial cone is formed of volume V_s, equalling

$$V_s = b \cdot P_s \cdot A \tag{14}$$

where P_s is the area of the base of the cone, A = its maximum height, and b a coefficient depending on the shape of the cone.

As we know, a cone of this type is built of the material denuded from the valley. Since part of this material is carried off beyond the cone, we have

$$V_s = k \cdot V_d \quad (\text{where } k < 1) \tag{15}$$

Substituting in Equation 15 the values of V_d and V_s by the values from Equations 13 and 14 and calling $\frac{b}{k \cdot a} = K$, we obtain:

$$\frac{E}{A} = K \frac{P_s}{P_d} \tag{16}$$

With the gradual development of these forms the volumes of V_d and V_s grow and become new values of V'_d and V'_s. The ratio of the initial forms to the new forms finds its expression in the formula

$$\frac{V'_d}{V_d} = \frac{k'}{k} \cdot \frac{V'_s}{V_s} \tag{17}$$

Without being inaccurate we may assume $k' = k$, thus $\frac{k'}{k} = 1$. By substituting the values for V'_d, V_d, V'_s and V_s, we obtain:

$$\frac{P'_d E'}{P_d E} = \frac{P'_s}{P_s} \cdot \frac{A'}{A} \tag{18}$$

Unless further tectonic movements appear along the line of the tectonic sill, E' becomes E and $A' = A$. If additionally we take into account in Equation 18 that $P'_d = P_d + \Delta P_d$ and $P'_s = P_s + \Delta P_s$, we ultimately obtain

$$\frac{\Delta P_d}{P_d} = \frac{\Delta P_s}{P_s} \tag{19}$$

denoting a proportional development of the surface of an erosive form and of an accumulation form genetically connected with it.

If it happens that a further development of these forms is brought about by a tectonic movement E' becomes $= E + \Delta E$ and $A' = A + \Delta A$, and Equation 18 ultimately takes the form:

$$\left(1+\frac{\Delta P_d}{P_d}\right)\left(1+\frac{\Delta E}{E}\right)=\left(1+\frac{\Delta P_s}{P_s}\right)\left(1+\frac{\Delta A}{A}\right) \tag{20}$$

Assuming, in accordance with Equation 19, that the development of the surfaces of both the forms is proportional we obtain

$$\frac{\Delta E}{E}=\frac{\Delta A}{A}, \quad \text{or} \quad \frac{\Delta E}{\Delta A}=\frac{E}{A} \tag{21}$$

Elimination of ΔE and E on the basis of Equation 10 leads to the formula

$$\frac{\Delta A}{\Delta T}=\frac{A}{T} \tag{22}$$

On the basis of Equations 21 and 22 we now can put down, as third equation,

$$\frac{\Delta E}{\Delta T}=\frac{E}{T} \tag{23}$$

Equations 21, 22 and 23 represent the "principle of proportional development" of the vertical dimensions of erosive and accumulative forms with regard to each other and to the amplitude of the tectonic movement.

5. Tectonic movements are recorded in the pattern of the successive deposits [11, 13, 15]. Thus we are able to determine, by observation and by analyses of material gained from drillings, the thicknesses of rhythms ΔA_n and the total thickness of the correlative deposits A. Furthermore, by observation it is possible to establish the erosive incision E in the old uplifted surface as it existed initially. With both A and E known, the total amplitude of the tectonic movement T can be calculated by means of Equation 7.

In turn, with the values of A, E and T known there can be calculated, using Equations 21, 22 and 23, for every ΔA_n the corresponding values of ΔT_n and ΔE_n; they are:

$$\Delta T_n=\frac{T}{A}\Delta A_n=\frac{T}{E}\Delta E_n; \quad \Delta E_n=\frac{E}{A}\Delta A_n=\frac{E}{T}\Delta T_n$$

Applying Equations 11 we now obtain the values of A_n, T_n and E_n.

Beginning with Equation 4 and entering in it for z_{01} the absolute altitude of the bottom of the correlative deposits z_0, and making-$T_1 = 0$, we obtain the present-day absolute altitude of the n-th fossil level:

$$Z_{A_n}=z_0+A_n \tag{24}$$

In an analogous manner, starting from Equation 5 and making $+T_2 = +T$, we obtain the present-day altitude of the n-th erosive level:

$$Z_{E_n} = z_0 + T - E_n \tag{25}$$

In spite of today's difference in their altitude, the n-th accumulative level and the n-th erosive level formed initially a common level of the hydrographical system. If the deposits of the n-th rhythm have been dated, the same age should be allotted to the n-th erosive level.

The altitude of the erosive level, calculated by means of Equation 25, corresponds only approximately to the altitude observed in the field, due to the fact that since its formation this level has suffered further changes.

6. I have used the method described above for correlating young erosive levels of the Middle Sudety Mountains with correlative rhythms of deposits found in the Sudety foothills. On the basis of my own field observations [14] and of data from other literature [4. 12] I have ascertained that the amplitude (throw) of the marginal fault in the Sudety Mountains in their middle section is more or less uniform, amounting to 350 m. On evidence from bore holes sunk in the Dzierżoniów depression, I succeeded in distinguishing in the correlative deposits 5 Neogene rhythms [14] and in determining their thicknesses A_n. Using this data I calculated: ΔT_n, A_n, T_n, ΔE_n E_n, as presented in Table 1.

TABLE 1. DEVELOPMENT OF THE SUDETY MARGIN IN THE NEOGENE

Rhythm	Thickness of deposits of rhythms ΔA_n	Increase in amplitude of fault ΔT_n	Total thickness of correlative deposits A_n	Total amplitude of marginal fault T_n	Increase in altitude of margin and magnitude of phasal dissection by rivers ΔE_n	Relative height of Sudety margin and depth of rivers incising the margin E_n	Period referred to in data calculated
V	21	65.5	112	350.0	44.5	238.0	Decline of Pliocene
IV	19	59.5	91	284.5	40.5	193.5	Lower Pliocene
III	13	40.5	72	225.0	27.5	153.0	Decline of Miocene
II	20	62.5	59	184.5	42.5	125.5	Upper Miocene
I	39	122.0	39	122	83.0	83.0	Middle Miocene
Σ	112	350.0	—	—	238.0	—	—

This Table not only supplies a concept of the devolepment of the Sudety margin, but also aids us in the reconstruction of the position of the rock stratum of the foothills with regard to the Sudety Ridge during the successive phases of the upheaval of this ridge (Fig. 3).

This figure already enables us to define the age of the successive Sudety froms by applying the following principle viz.: any forms lying above an investigated foothill profile of a defined age are older than this profile, and any forms lying lower, are of younger age.

Working on the assumption that the values T and ΔT_n are constant for the marginal fault of the Middle Sudety Mountains, and defining on the basis of field observations or of calculations the values of E or A for various points situated along the Sudety margin, I calculated the present-day altitudes of the erosive levels surrounding these points. The results of these calculations are presented in Table 2. In this Table I gave, alongside of the values calculated, the altitudes of the erosive peneplains as were observed by various authors [1, 4, 12, 16].

TABLE 2. AGE AND ALTITUDE OF EROSIVE PLAINS IN SOME REGIONS OF THE MIDDLE SUDETY MOUNTAINS

Age of erosive plain	Nysa Kłodzka water gap			Sowie Góry margin			Wałbrzych Sudety			Bolko Upland		
	Altitude in m			Altitude in m			Altitude in m			Altitude in m		
	calculated	field observation	difference	calculated	field observation	difference	calculated	field observation	difference	calculated	field observation	difference
Decline of Palaeogene	560	560—580	0	548	c. 500	+48	530	500	+30	570	completely destroyed	
Middle Miocene	455	c. 450	+5	465	c. 450	+15	443	c. 450	— 7	465	,,	
Upper Miocene	402	400	+2	423	c. 400	+23	398	400	— 2	417	420	—3
Decline of Miocene	366	360—380	0	395	360—380	+15	369	360—380	±0	384	380	+4
Lower Pliocene	316	300– 310	+6 c	355		— 5	326	315	+11	335	320—340	±0
Decline of Pliocene	260	260		310	310		280	280		280	280	

Table 2 illustrates a satisfactory concordance between the calculated absolute altitudes of the erosive levels and the levels observed in the field. The differences show mostly a plus sign, — thus they may partly be ascribed to subsequent degradation of the levels assumed.

Moreover, this table is the first to define the age of all the levels. In previous studies the age of only some of the levels were defined [1, 4, 8, 9, 16] and, partly, erroneously. As regards the Bolko Upland I was able even to calculate the heights of levels which were completely degraded, — data probably of importance in palaeogeographical discussion.

7. The application of the mathematical method described of correlating erosion levels with rhythms of correlative deposits, showing true results in the correlation of erosive levels of the Middle Sudety Mountains with deposits of the Sudety foothills, is proof of the value of this method and of the correctness of the principles on which it has been based.

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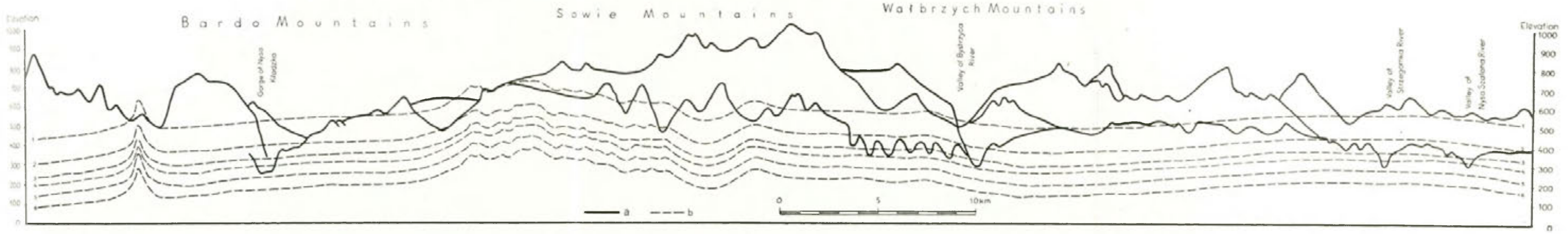

Fig. 3. Hypsometrical conditions between the Middle Sudety Mountains and their foothills during various Tertiary periods

a — modern profile of the Middle Sudety Mountains, b — profiles of the rocky foothills during various Tertiary periods: 1) towards the decline of the Palaeogene (preceding the Savan Phase), 2) during the Middle Miocene (following the Savan Phase), 3) during the Upper Miocene (following the Old Styrian Phase), 4) during the decline of the Miocene (following the Young Styrian Phase), 5) during the Lower Pliocene (following the Attic Phase), 6) during the decline of the Pliocene (Rhodanic Phase)

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RESEARCH ON THE INFLUENCE OF MICROORGANISMS ON THE DEVELOPMENT OF KARST PHENOMENA

Bolesław Smyk, Maria Drzał

In 1960, the authors undertook investigations on the appearance and role of the microflora in karst processes of calcareous rocks. The research work was carried out in chosen areas of calcareous rocks occurring in the following countries:

a) Poland — the Świętokrzyskie Mountains, Roztocze, Kraków Upland, Pasmo Skalicowe (Klippen Belt), the Tatra Mountains;

b) Yougoslavia — Dalmatian Coast, Istria Peninsula;

c) Switzerland — Vallée de Joux — Jura, Sottoceneri — Monte San Salvatore, Glattalp, Bernina Pass — Piz Alv;

d) Czechoslovakia — The Belanské and the Nižne Tatras, the Liptov Alps.

The role of the microbiological factor in karst processes has not hitherto been known, this problem having been only signalized in literature on the karst. The authors, on the basis of a collaboration of two disciplines of science, i.e. microbiology and geomorphology, expected to achieve confirmation of their theoretical considerations through detailed investigations and experiments on the possibility of the existence of microorganisms on the surface and inside the calcareous rocks, which might accomplish, in a biochemical way, a determined role in the processes of transformation of the calcareous substratum.

Investigations were carried out in terrains with a substratum composed of calcareous rocks of different age and a different lithological development. These were, in the first place, calcareous rocks and dolomites belonging to the Devonian, Triassic, Jurassic, Cretaceous and Tertiary strata highly resistant to the action of mechanical and physical factors and having a considerable CaO content.

The surfaces of karst limestone were situated at an absolute altitude of 250-2500 m a.s.l., they had a differentiated exposition and inclination and their climatic conditions varied. The terrain of investigation, and especially the places where rock material was collected for microbiological study, provided a maximal guarantee for conducting the work in a natural environment (protected areas). As to the detailed situation of localities where samples were collected, depth, humidity etc. were taken in consideration.

Geomorphological study of the areas, chemical and petrographical research on the substratum, and microbiological investigation of rock samples were carried out.

The microbiological investigations (method of investigation as presented in the works of Smyk and Drzal [1, 2] and Smyk and Ettlinger [3] were as follows:

a) the appearance of some physiological groups of heterotrophic and autotrophic microorganisms was determined, namely: ammonifying microorganisms, nitrifying bacteria, anaerobia assimilating free nitrogen, aerobia assimilating free nitrogen, sulphur bacteria, microorganisms dissolving $CaCO_3$, bacteria dissolving $Ca_3(PO_4)_2$ and bacteria dissolving aluminium silicate;

b) taxonomic determination of microorganisms active in karst processes was carried out;

c) the influence of some products of the metabolism of selected microorganisms on decomposing-dissolving of calcium carbonates and phosphates and aluminium silicates was investigated. These investigations lead to the following conclusions:

1. The occurrence of the following groups of microorganisms was ascertained: chemo- and photosynthetic (autotrophic and heterotrophic) bacteria, actinomycetes (Streptomycetes) and Fungi with various biochemical capacities, as for instance dissolution of phosphates and calcium carbonate, dissolution of aluminium silicates, production of organic acids (2-ketogluconic acid) and of mineral acids (sulphuric acid), production of CO_2 etc.

2. Of the investigated physiological groups of microorganisms, the following were the most numerously represented: bacteria dissolving calcium phosphates, calcium carbonates and aluminium silicates, ammonifying and nitrifying bacteria, photosynthetic sulphur bacteria (photolithotrophe and photoorganotrophe) and assimilating atmospherical nitrogen bacteria.

These microorganisms occured with a various frequency in all rock samples. Systematic appurtenance was differentiated and determined for 24 species of bacteria (including 7 newly differentiated strains of the genus Arthrobacter having, among others, the capacity of assimilating nitrogen from the atmosphere and dissolving aluminium silicates), 12 species of actinomycetes (Streptomycetes) and 40 species of Fungi capable of decomposing-dissolving calcium phosphates and calcium carbonates. Among the differentiated chemosynthetic heterotrophic bacteria microorganisms producing 2-ketogluconic acid and other active factors were the most numerous.

3. When taking in consideration the metabolic and biochemical activity of the distinguished physiological groups of the autotrophic (containing photosynthetic purple bacteria) and heterotrophic microflora, it must be stated that the products of their metabolism seem to prove that the microbiological factor takes part in the chemistry of karst phenomena. This thesis has been experimentally confirmed (*in vitro*) by using different minerals and associations of microorganisms.

4. The appearance of the microflora, not only on the surface of limestone but also in the interior of the karst substratum, has been ascertained.

5. Territories on which lithobiological investigations have been carried out are characterized by a typical karst sculpture with well developed associations of small forms of the lapies type. This microrelief demonstrated characters of a considerable vitality in many cases.

6. The calcareous substratum in the terrain investigated showed, in most cases, distinct macroscopic alterations of the rocky surface. The greatest intensity of these changes was connected with the concave forms of the karst relief. On these karst territories microorganisms developed in great numbers. They were represented by different physiological groups of bacteria, Fungi and actinomycetes (Streptomycetes), the biochemical activity of which developed in diverse directions and was distinguished by a considerable activity.

7. The results of investigations hitherto undertaken allow to state that, considering the role of microorganisms in the transformation of the calcareous substratum, the microbiological factor ought to be taken into account when studying the genesis and development of the karst in different climatic zones.

8. It should be stressed that the role of microorganisms in the karst processes of calcareous rocks is an extensive and complicated problem, one of those concerning the relation of microorganisms to an element of inanimate nature such as the rocky substratum continously shaped by various processes taking place on its surface and in its interior. A complete solution of this new and interesting question belonging to the karst problems requires further thorough studies and a vast cooperation of specialists from the different branches of natural sciences.

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CHRONOLOGY OF DENUDATION PROCESSES IN THE LAST GLACIAL PERIOD IN THE FLYSCH CARPATHIANS

LESZEK STARKEL

The chronology of the phases of degradation during the last glacial period is based on the stratigraphy of slope deposits of fluvial sediments and on an analysis of the mutual relations between land forms and deposits.

The succession of processes ought to reflect the climatic changes that had a bearing on the type of the particular processes, and the relation of river transport to slope transport; they should also correlate with the geology and topography of the terrain. The sequence of covers, providing a basis for the reconstruction of the phases of denudation, varies, hence it is most important to estimate the value of the particular profiles whose position in relation to the slope and the bottom of the valley varies, too. Profiles of covers from the last glaciation period, displaying the strongest differentiation, are encountered within river terraces of the same glacial period (height 6-15 m a.s.l.), at the foot the slopes leading up to them, and on the higher flattened surfaces of the terraces which are the base for the slope processes.

Eight types of the sequence of deposits of the last glacial have been distinguished by the writer within the Carpathians and their immediate foreland (Fig. 1, sections I—VIII).

I. No sharp boundaries between the particular horizons are indicated in the profile. The lower gravels grade into gravels intermixed with solifluction debris, and higher up into solifluction clay with debris, and sandy or silty proluvia. The profile indicates a gradual increase in slope transport and a decrease in stream energy in the course of glaciation. The proluvia which occasionally descend as far as the late-glacial erosion terraces (Beskid Wyspowy [20], na Grelu [13]) indicate that there was a deposition of proluvia during the duration of late-glacial erosion. This sequence pattern is characteristic of small valleys with a large slope transport (Biała Wiselka, the tributary valleys of the upper San river).

II. The thicker series of river gravels often display distinct bipartition. They are divided by stream deposits from the flood facies (silt, muds and others), or proluvial deposits, and frequently contain interstadial peat (Ziębowka [11, 23], Białka Tatrzańska [18, 22], the Strwiąz valley [9]), which suggests the work of erosion at a time of diminished slope transport. Two gravel

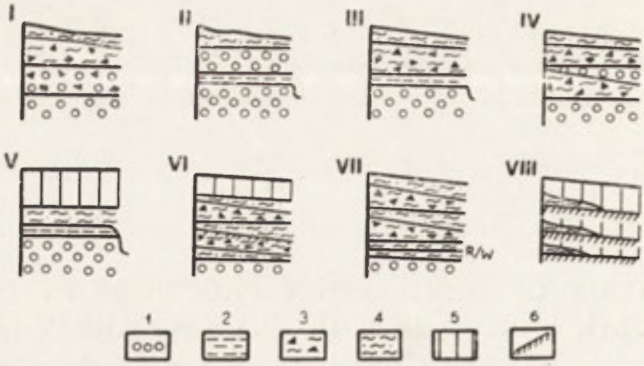

Fig. 1. The types of sequence of fluvial and slope deposits in profiles of the last glaciation. For explanations of the particular sections see the text (I—VIII)

1. gravels — stream bed facies, 2. haugh-loams, sands, peats — terrace (flood) facies, 3. solifluction covers, 4. proluvial (deluvial) covers, 5. loess, 6. fossil soil

series, on the whole poorly rounded, indicate the occurrence of two cool stadial periods. The upper gravel series are covered by proluvia (sometimes by solifluction). These profiles occur in the upper section of the larger valleys, the axial zone of the terrace.

III. The lower gravels and clays of the flood facies (with interstadial peat e.g. at Brzeziny, Maniowy [2]) are overlain either by a thick series of solifluction clays with detritus and a thin bed of proluvial deposits, or by fans of the tributary streams of Maniowy and Wołkowyja. This sequence pattern is encountered in the marginal zones of the floors of large valleys. The absence of upper gravels — a deposit of the main stream — indicates that during the younger stadial (the coolest period of the Wurm glaciation — comp. Wolstedt [26]; the B pleniglacial according to the terminology of Zagwijn [27]) lateral transport was more intense than previously had been the case.

IV. A thick (up to 10-15 m) solifluction series, containing Dryas flora, and with the top occasionally covered by proluvial deposits, rests on the bottom gravels. Among the solifluction clays, in about the middle of the series, occur horizons of fairly well rounded gravels which, in this case, represent a warmer period — of the outwashing of solifluction deposits. No deep erosion, however, has occurred here (comp. profile II). Such profiles have been noted by the writer in the axial parts of small valleys where fluvial deposits intertongue with solifluction deposits (Lipowe [20], Dziurdziów). These profiles are also typical of parts of the moderately large velleys, adjacent to the slope (Dobra [12]), where lateral erosion continued during the interstadial [20].

V. On the gravels or sands rest flood haugh-loam series, covered by proluvial or solifluction clays that grade towards the top into a loess series. The haugh-loam horizons indicate deep erosion. On the basis of peat intercalations in these loam fluvial sediments, the erosion may be ascribed either to the interstadial period [4, 24], or to the cooler stadial period (at Zator [25] according to radiocarbon^{14} dating more than 40,000 yrs.). Such profiles occur in the marginal zone of the Carpathian foothills, and in the sub-Carpathian basins (Kaniów, Oświęcim, Zator [23], Ściejowice [4], Rzeszów [10]). They indicate that the relief of the so called loess terrace was carved out by fluvial waters during the early glacial period or the still older stadial of the proper glacial period) pre-Paudorf, in the A pleniglacial)[1]

[1] If it is recognized that no major interstadial interval occured between the Brørup and the Paudorf interstadials [26].

VI. A unique type of sequence is represented by the nearly 20 m thick profile of an exposure at Wadowice. There peat from the Brørup [25, 17] interstadial rests on an erosion surface of the early Würm age; the peat is in turn overlain exclusively by alternating proluvial and solifluction slope series that have a distinct bipartite weathering horizon (oxidation and de-calcification) in the middle of the profile, and a loess admixture on the top. The occurrence of proluvial horizons both below and above the solifluction series is very characteristic; it indicates that the particular stadial periods began and ended with outwash phases [comp. 1, 5, 17].

VII. Similar bipartition of the solifluction series has been observed in covers overlying the terrace from the Middle Polish glaciation. In the river San valley [7] old-decalcified gravels are overlain by a decalcified proluvial solifluction series from the close of the penultimate glaciation period. In the Solina — Zabrodzie profile (in preparation) the Würmian slope covers, 15 m thick, start with proluvia on which rest the lower solifluction covers, the intermediate proluvia, the upper solifluction covers and the upper proluvia. The zone of weathering and the fossil soils that were degraded during the next stadial — have not persisted owing to the inclination of the slope (20° — 6°) and its overhanging position in relation to the stream bed. The exposure of the whole slope indicates that only solifluction covers occur in the upper part of the slope, while at the foot there are only proluvia — thus the facies of the deposits is seen to have undergone not only temporal changes but also along the slope. The presence of 2 solifluction series suggests two rather long cool periods.

VIII. The last type of profile (Fig. 1) — i.e. loess horizons with fossil soils in the top and solifluction or erosion horizons in the bottom, is unknown as the representative type from the Flysch Carpathians (frequent in Moravia [15] and the Małopolska Upland — [5]). The only fossil soil horizon in interstadial loesses was found near Przemyśl by A. Malicki [16].

The above presented types of sequence in slope and fluvial deposits suggest that various causes are responsible for this differentiation. The most important ones are probably: facial variability in the sequence pattern of deposits in the cross section of the valley-slope axis, differences in the filling and cutting of different-sized valleys, heterogeneous geological structure and variations in the erosional activity, as well as variations in the amount of transport in the longitudinal section of the Carpathian streams, from the Beskidy range to the sub-Carpathian basins.

The variability of covers in the cross section of the valley-slope axis is best illustrated by outcrops at Solina-Zabrodzie [7], Wadowice [17] and in the Beskid Wyspowy [12, 20]. The solifluction and sometimes talus debris covers of the degraded segment of the slope are replaced at the foot of the slope by proluvial deposits containing solifluctional intercalations, while in the axis of the valley they are replaced by alluvial deposits of a variable facial development and varying degree of rounding (which was not so good in stadials). In the marginal zone of the valley bottom, the slope-and fluvial deposits either intertongue owing to simultaneous transport, or they are mutually superimposed, depending on the alternating predominance of longitudinal (interstadial) or lateral (stadial) transport (comp. Fig. 2A).

The size of the valley is also important. Within large valleys the accumulation of poorly rounded gravels during stadial periods alternated with interstadial deep erosion (similar erosion terraces occurred in the late glacial period [13, 20] and with the accumulation of haugh-loam or proluvial deposits on terraces. In small valleys (Lipowe, Dziurdziów) or in those with a very abundant slope transport (Dobra) the whole valley bottom was buried under solifluction deposits. During the interstadial periods these were outwashed. The gravels represent here the warmer oscillations [20]

The resistance of the rocks influenced the type of slope transport during the glacial period. On slopes built mainly of argillaceous shales solifluction was predominant throughout nearly the whole period of glaciation (creeping occurs there even now [21]. Hence, coarser proluvial deposits are absent at

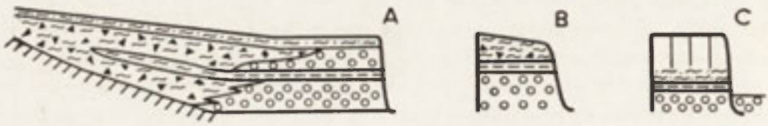

Fig. 2. Typical schematic terrace sections from various sectors of the large valleys of the Carpathians.
A. In the Beskidy zone (upper) grading into covers mantling the slope, B. in the Carpathian foothills (middle) zone, C. at the exit of the Carpathians into the forefield
Key as in fig. 1.

the foot of slopes in the Beskid Wyspowy range [12, 20]. Occasionally a thick series may consist of horizons some of which display stronger solifluidal than others. This indicates the occurrence of climatic oscillations (Krościenko [14]). In narrow tributary valleys of the Śląski and Wysoki Beskid ranges, carved out in thick-bedded sandstones, the weathering waste sliding down the steep hillsides filled the valleys with monotonous talus covers. On the other hand, in mixed sandy-shaly complexes that supplied large amounts of sandy-clayey detritus e. g. in the San river basin, the transport could be heterogeneous as a result of climatic oscillations. The heterogeneity of transport varied depending on climatic oscillations. This most distinctly indicated at the foot of the undercuttings in the rock (Wadowice [17], Zabrodzie [7]). It was there possible to trace the predominance of solifluction transport during the maximum of the stadial periods and that of downwash transport at the beginning and the close of these periods.

The strong variability of deposits in sections of the terraces is observable along the course of the larger Carpathian valleys (of the Vistula, the Skawa, the Dunajec, the Wisłok and other streams). In the upper sectors of the Beskidy fluvial accumulation as a rule reaches the top of the terrace, bipartition being indicated within the alluvia (Fig. 2A). Stadial gravels intertongue with solifluction covers. In the middle sectors (within the greater part of the Carpathian foothills and in the intramontane depressions), the lower gravels are overlain by fossil haugh loam and proluvial deposits (the interstadial break), which are coated by a thick horizon of clayey-detrital soil flow material, lateral fans and proluvia (Fig. 2B). Hence, it can be deduced that the terrace plain had already been cut during the younger pleniglacial period. In the "lower" sectors — on the escarpment of the Carpathian foothills and in the sub-Carpathian basins the early-glacial alluvial covers and alluvial fans had in many cases been covered already during the older stadial (before the Paudorf interstadial) by proluvial and haugh loam covers and later on by loess (Fig. 2C). This means that the cutting of the alluvial surfaces occurred during the maximum of the Wurm and that the rivers did not again attain the level of the loess terrace [25]. And yet late-glacial deposits, and even

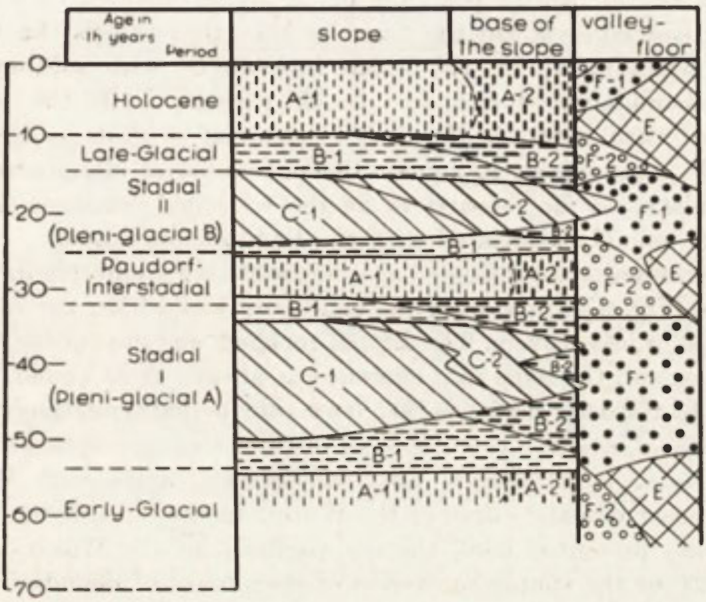

Fig. 3. Variability and sequence of processes on slopes and valley floors of the Carpathians during the last glaciation.

A–1 period of chemical weathering and weak downwash, A–2 period of chemical weathering and weak accumulation (deluvial, proluvial), B–1 period of strong downwash — degradation, B–2 period of strong downwash — accumulation of proluvial covers, C–1 period of soil-flow degradation, C–2 period of accumulation of soil-flow covers, E– predominance of deep erosion in valley bottom, F–1 predominance of fluvial accumulation in stream–bed facies, F–2 predominance of fluvial accumulation in terrace facies.

cool Dryas-flora-bearing deposits (of cool oscillation) [11, 24] have been found at the bottom of a Holocene terrace. The age of the terrace surface from the last glaciation varies along the stream course. The farther upstream, the later was the cutting. Differences in the pattern of the intersection caused differences in the sequence of terrace deposits. Hence, the slope series cropping out at some distance from the stream beds (Wadowice, Zabrodzie) gain in significance for the study of the phases of denudation.

The reconstruction of the succession of the processes of denudation on slopes and of the corresponding processes on valley bottoms from the last glaciation (Fig. 3) are based on the last named profiles and on an analysis of the position and stratigraphic values of all the terrace profiles. Two distinct solifluction phases are indicated on the slopes. They are preceded and followed by phases of outwash, probably in a drier climate [6, 26]. These two tripartite periods correspond to two long stadial phases separated by an interstadial period of chemical weathering. After Wolstedt [26] this interval is connected by the writer with the Paudorf interstadial. Since at Wadowice the lower soil flow series rests on Brørup peat, the pleniglacial is divided into 2 parts by the Paudorf interstadial. On the floors of the large valleys the bipartition of alluvial series [2, 7, 13, 22] which intertongue with solifluction ones, indicates accumulation during two cooler periods, while the intervening haugh loams with subfossil floras and proluvial deposits suggest erosion (Paudorf). It is reasonable to assume that a number of interstadial floras in the Carpathians, so far referred to as the so called Aurignac interstadial [24], may be reliably associated with the Paudorf interstadial.

The sequence pattern considered above is probably applicable in the Flysch Carpathians [Fig. 3] whose marginal zone only was within the reach of the accumulation or loess covers. The Flysch rockbed was susceptible to solifluction processes and the mountain climate was always more humid. The usual bipartition of the last glacial period (two cool periods, relatively humid in the Carpathians), also the occurrence of distinct transition phases into interstadials or late glacial periods (proluvial phases) agree with Woldstedt's [26] most recent climatic curve of the Würm. In the light of the variability of the profiles presented here, the non-partition of the Würm, as claimed by Büdel [2], or the simple succession of the phases of denudation (fluvial, soil-flow, loess), based on single terrace profiles [8, 19], is hardly acceptable.

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TOPOCLIMATOLOGICAL INVESTIGATIONS ON HEAT BALANCE

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The main problem with which modern climatology is concerned undoubtedly is the heat balance of the earth's suraface. The thermal and moisture régimes of the atmosphere depend upon the heat exchange at the boundary surface between the atmosphere and the underlying ground. This exchange has considerable influence on the existing climatic conditions. For this reason, the knowledge of the heat balance of the earth's surface is essential for a proper understanding and causal explanation of nearly all physical phenomena occuring in the air-layers near the ground. Here, above all the variations of the temperature and humidity of the air as well as of the soil should be mentioned.

The heat balance of the earth's surface (often called the active surface) can be shown in a simplified equation form:

$$R + B + P + E = 0$$

where: R is the heat exchange through radiation,
B is the heat exchange with the underlying ground through conduction,
P is the heat exchange with the atmosphere through convection,
E is the latent heat exchange.

Other forms of heat exchange do not play any considerable role from the energy point of view and may be omitted, or subsumed within the main components mentioned above: for example heat transferred with precipitations can be dealt with as part of component P, and heat used for photosynthesis as part of component B. If considering the heat balance not of the active surface but of the so-called active layer (which is nearly always identical to the vegetational layer), it is necessary to introduce an additional component A to the heat balance equation. This component would represent heat storage in this layer, that is to say, the amount of heat accumulated in it or delivered from it. It is obvious that each component of the heat balance can gain either negative or positive values, a fact depending mainly on the sign of the radiation balance.

The values of each component of the heat balance and their mutual relations, which may be called the balance structure, depend on many different factors. We can divide all the factors that cause the variations of heat balance in time and space into three groups: a) planetary (astronomical factors), b) regional (atmospheric factors), c) local (geographical factors).

The astronomical factors, such as latitude, decide the zonal distribution of heat balance on the globe, and its seasonal as well as its daily variations. The distribution of the heat balance over large areas and its irregular changes in time depend on atmospheric factors, mainly atmospheric circulation. From the topoclimatological point of view, however, the most important are local factors, which also may be described as "the character of the earth's surface". This term corresponds more or less to the concept of geographical environment. This character decides the geographical distribution of all the heat balance components within small areas. Therefore local varieties of the daily and seasonal course of the structure of heat balance are apparent as a result of the differentiation of the geographical environment. On the other hand, we can assume that within such small areas of several km^2 both the atmospheric and astronomical factors are not differentiated.

The division presented here is a conventional one, and the inclusion of a given factor into one or other group may be doubtful. On the other hand, this division corresponds somewhat to the three main principal climatic factors: solar radiation, atmospheric circulation, and character of the underlying surface, according to the definition of climate by Rubinshtein and Drozdov [1].

The heat balance structure and its formation under the influence of local factors, was the main subject of topoclimatological investigations undertaken in 1962 by the Departament of Climatology of the Institute of Geography, Polish Academy of Sciences. The investigations were conducted within a small area of about 5 km^2 in the neighbourhood of the Research Station of the Institute at Wojcieszów in Silesia. The general topographical features of that area are presented on the map attached (Fig. 1). The map shows that the area has varied relief, and the differences in altitude attain 250 m. Elevations are mainly composed of limestones and slates covered with a thin layer of slope soil. In the valleys there are mainly alluvial soils. The upper parts of the hills are mainly covered with forests. The gentler parts of the slopes are used for agricultural purposes with predominantly grain and root crops (potatoes and sugar beet). Within the areas of arable land tree belts have been planted vertical to the slopes. The valley bottoms are mostly covered with moist meadows.

The main purpose of these investigations was to discover the distribution of the individual components of the heat balance within the limits of area studied. However, it would be too difficult to survey directly all these values forming the heat balance equation because of their considerable periodical variations as well as irregular changes depending on the weather. Therefore it would seem necessary to survey one particular component during different seasons, during different times of the day and in different weather conditions. Such a survey, even on a small scale, would require too much work and expense, and therefore it would be practically impossible to execute it with the required degree of accuracy.

For this reason it is necessary to resolve this problem in another way. The method which has been applied is not based on the direct mapping of the individual components of the heat balance but on that of those numerical parameters which determine quantitatively the influence of the local factors mentioned above on the balance structure. The parameters undergo much

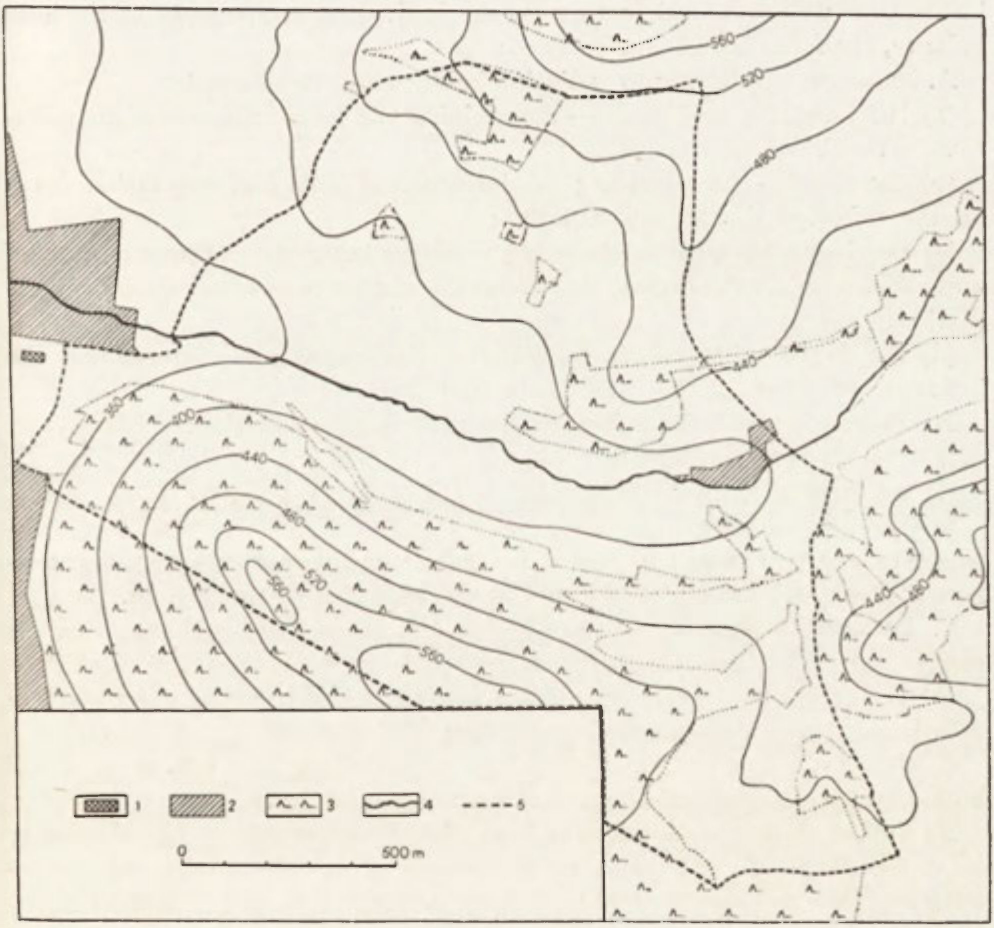

Fig. 1. Map of the area investigated.
1 — Research Station at Wojcieszów, 2 — Built up area, 3 — Forests, 4 — Streams, 5 — Limits of the area investigated

smaller changes and variations in time than the components of the heat balance, and in some cases we can assume that their values are constant [4]. Taking these parameters into consideration, we are dealing here with values which enable us to compute the structure of heat balance without having to perform the detailed field measurements in different seasons and in different weather conditions. If we know the distribution of these numerical parameters within the area investigated, we can compute the components of the heat balance in any one spot provided we have their absolute values at one point only. Moreover this method is a means of illustrating the influence of individual elements of the geographical environment on the heat balance of the earth's surface in topoclimatic scale.

From among the numerical parameters which enable us to compute the influence of different local factors on the individual components of the heat balance, the following should be listed:

A. Parameters referring to radiation balance and its elements:

(a) the turbidity coefficient — determining the local influence of air pollution on the direct solar radiation [7];

(b) the albedo — determining the influence of soils and vegetation cover on the reflected short-wave radiation;

(c) the index of horizon screening — determining the influence of relief and vegetation on the diffuse sky radiation and on the atmospheric back-radiation;

(d) the degree of terrain inclination and its exposure — determining the influence of relief on the direct solar radiation.

B. Parameters referring to heat exchange through conduction:

(e) the thermal conductivity of soil;

(f) the thermal diffusivity of soil;

(g) the heat capacity of soil.

These parameters determine the influence of the mineral composition, moisture content and density of the soil on the heat flux in the ground.

C. Parameters referring to the sensible and latent heat exchange through convection:

(h) the roughness parameter — determining the influence of relief and vegetation on the turbulent heat exchange;

(i) the coefficient of water covering — determining the influence of soil humidity and of vegetation on the evapotranspiration.

As the list shows, we are dealing here with values which are not absolutely constant. Some of them, such as the albedo or the thermophysical characteristics of the soil can be subjected to considerable seasonal or daily changes. This variability, however, is rather slight in comparison with the variations of the balance components and, therefore, in many cases we can assume the average values of certain parameters with a sufficient degree of accuracy.

In other cases, however, it is necessary to delimit their validity periods.

As a result of field investigations conducted by the Department of Climatology, detailed maps of the parameters mentioned have been prepared. The topoclimatological mapping of the described area was carried out on a scale of 1 :10000. Three examples of such maps are given: the map of the albedo (Fig. 2); the map of the index of horizon screening (Fig. 3); the map of the heat capacity of soil (Fig. 4).

The map of albedo [5] was prepared partly using measurements made in the field, and partly on the basis of data found in the extensive literature dealing with this problem [3]. In regard to forests, results already received by different investigators were used because technical difficulties made it im-

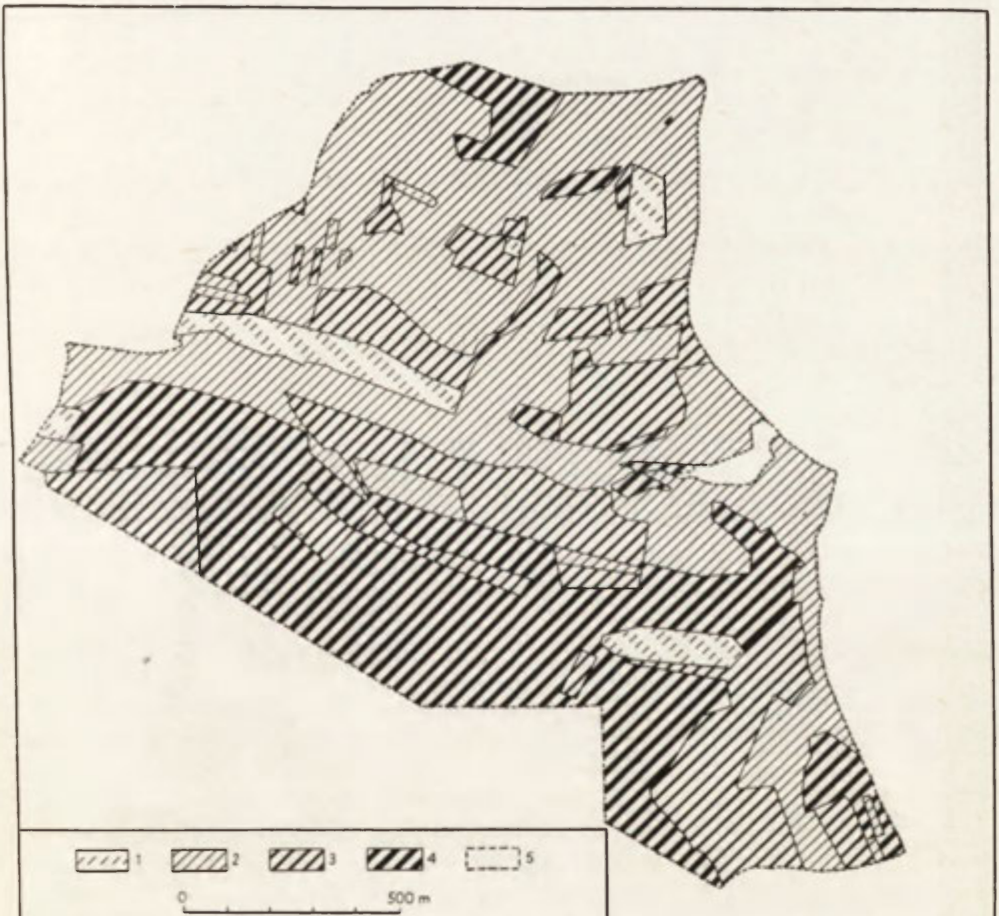

Fig. 2. Map of the albedo.
1 — 25-30%, 2 — 20-25%, 3 — 15-20%, 4 — 10-15%, 5 — Limits of the area investigated

possible to perform the direct measurements of the albedo over the woodland. This map, as well as the others presented here, concern the main vegetative period July — August. It shows the albedo values in intervals of 5%. Two different types of terrain were differentiated: those in unchanging use (forests, meadows, barren land and built-up areas), and lands with a changeable use (agricultural fields). For this last type of terrain the average albedo value was computed as 21%. Taking into consideration the crop rotation that has been applied, this value would be characteristic not only for the year 1962 when the measurements were made but also for other years. The map enables us to compute the short-wave radiation balance in any chosen place using the recordings of global radiation made at the Research Station.

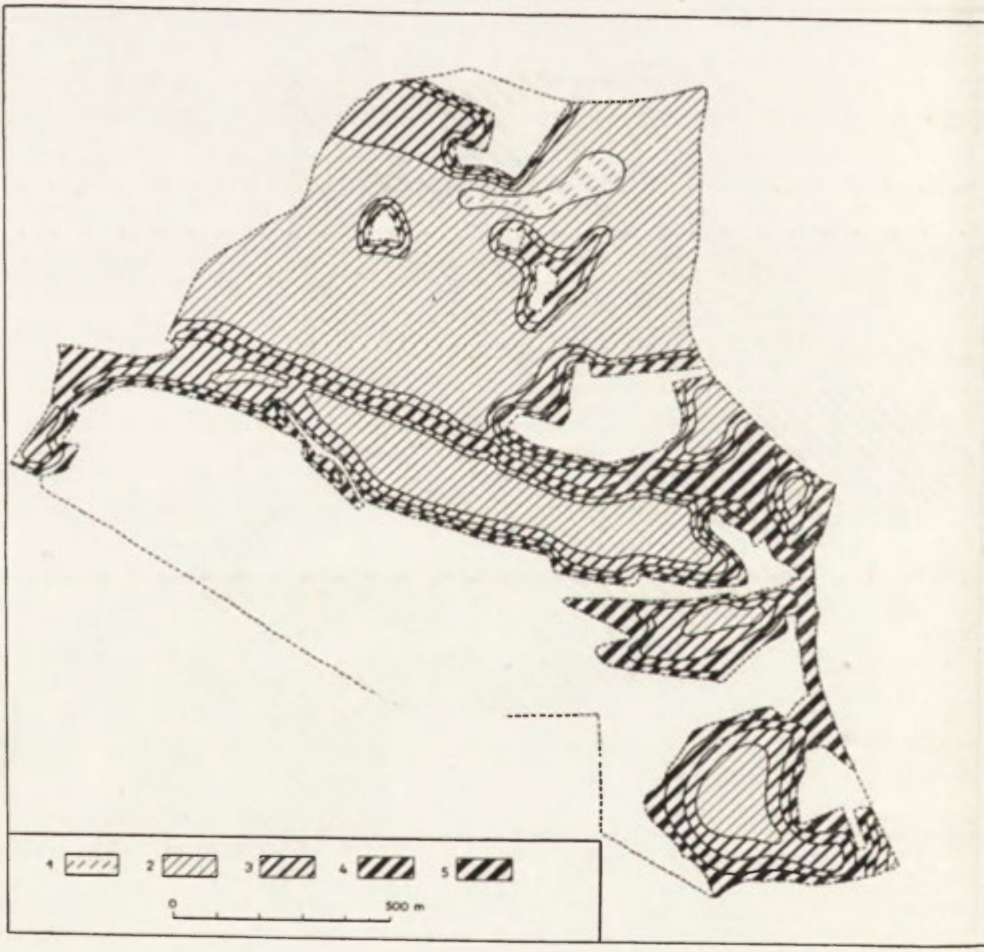

Fig. 3. Map of the index of horizon screening
1 — 95-100%, 2 — 90-95%, 3 — 85-90%, 4 — 80-85%, 5 — Below 80%

The map of the index of horizon scereening [6] presents the percentage values of atmospheric back-radiation for clear sky conditions relative to the corresponding values in the flat terrain with unscreened horizon. This map enables us to compute the long-wave radiation balance, knowing its value from the direct measurements made at the Research Station and assuming that the surface temperature of the entire area investigated and its vicinity is uniform. Isolines were plotted on the map at intervals of 5%. The map was based on one hand on the results of horizon screening measurements, and on the other hand on the known anisotropic distribution of atmospheric back-radiation on the sky [2]. It takes account of differences in atmospheric radiation resulting from the screening of the horizon by slopes,

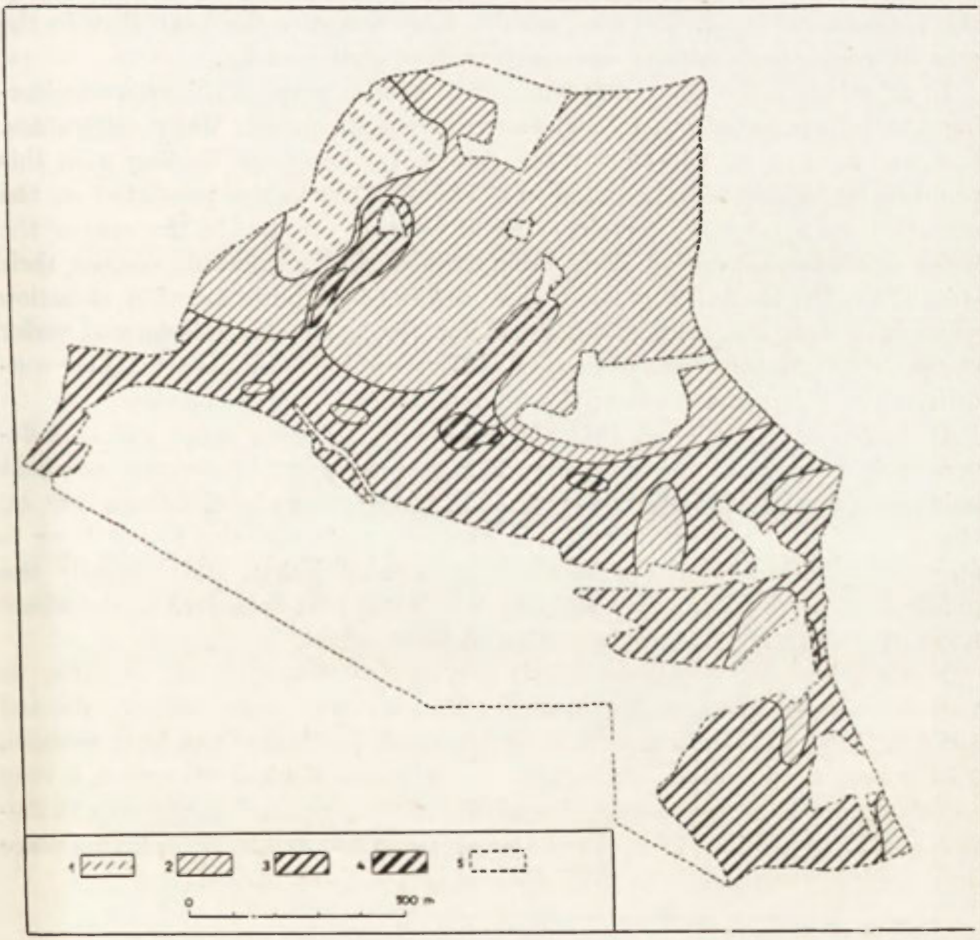

Fig. 4. Map of the heat capacity of soil
1 — Below 0.4 cal. per cm^3 and °C, 2 — 0.4-0.5 cal. per cm^3 and °C, 3 — 0.5-0.6 cal. per cm^3 and °C, 4 — Above 0.6 cal. per cm^3 and °C, 5 — Limits of the area investigated

forests, buildings etc., as well as from terrain inclination at the point of measurement. The forests were omitted on the map because in their case the active surface consists of the upper surface of the wood and from that surface the horizon screening should be measured.

The third map shows the heat capacity of soil (to the depth of 20 cm). To draft this map the average values of soil humidity were assumed. The soil humidity were measured in about 60 places in the area during the summer period of 1962. The mineral composition of the soil and its density were also determined in the same places. The isolines of heat capacity were plotted for each 0.1 cal per cm^3 and °C. Again in this case the forests were omitted. The heat capacity of soil in the forests does not play such an important part as it does in open areas. This is due to the considerable amount of heat stored in the vegetational layer. The map enables us to compute the heat flux in the ground using the results of soil temperature readings only.

In addition to the three maps included, similar maps of this area considering the influences of other local factors are anticipated. Many difficulties, however, are expected in the preparation of further maps dealing with this problem. It should also be noted that some of the values presented on the maps can be applied for certain types of weather only, as in the case of the index of horizon screening. This circumstance can considerably restrict their suitability. On the other hand, we are dealing here with so-called radiation weather — clear and calm weather — when the heat balance is formed under the decisive influence of local factors. Only these kinds of meteorological conditions are of importance from the topoclimatological point of view.

It should be remembered that the knowledge of some other values independently of the parameters mentioned is also necessary to compute the heat balance components. These values are not dependent on local factors but on the predominant weather conditions. The temperature of the active layer is an example, being important for the long-wave radiation, and similarly the potential evapotranspiration limiting the latent heat transfer.On the whole however, it is rather easy to determine all these values.

Nevertheless, the usefulness and importance of the maps are obvious, as various climatologists, as for example Thornthwaite, have already pointed out [9]. It would seem that this approach to the problem of the heat balance, taking into consideration the factors of topoclimatological influences, is very suitable from a geographical point of view. This approach enables us to discover the regularities which rule the processes of energy exchange taking place on the earth's surface under the influence of local conditions.

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GEOGRAPHIA POLONICA 2,1964

AN ATTEMPT AT THE CLIMATOLOGICAL CLASSIFICATION OF THE HEALTH RESORT OF CIECHOCINEK

TERESA KOZŁOWSKA-SZCZĘSNA

1. INTRODUCTION

In the years 1957—1959 a detailed climatological investigation was carried out on the area of Ciechocinek, one of the oldest and most appreciated Polish health resorts, by the Department of Climatology of the Institute of Geography of the Polish Academy of Sciences.

The main purpose of the investigation was the division of those parts of the resort with varied climatological conditions.

This problem has a great practical significance not only because of the need to establish the main lines of the growth of the resort but also because of the need to determine the sites of future sanatoria, convalescent and recreational areas.

The first attempt at the division of Ciechocinek into climatic zones was carried out by J. Paszyński [4,5].

This present work tries to show the direction and the extent the geographical environment influences the climate in regards to its suitability for therapeutical and recreational purposes. The so-called "effective temperature" is the primary indicator of this suitability and represents the entire influence of the heat exchange between the environment and the human body.

Apart from the cognitive purpose, this work represents an attempt to apply a chosen method of research into the local climates of the recreational and health resorts.

2. THE CHARACTER OF THE INVESTIGATED AREA

Ciechocinek is a health resort situated on a plain within the Vistula valley, on an altitude between 40 and 46 m above sea level. The relief within the area of Ciechocinek is rather varied because on the flat terrain sweeps a run of sandy hills parallel to the river. On such a belt of dunes a greater part of the resort is situated. From both sides i.e. from north and south, Ciechocinek is bordered by low and often peaty lands. These lowlands are mainly soaked with a fairly high level of ground-water and they form a greater part of the so called *Nizina Ciechocińska* (Ciechocinek Basin). The ridge of the Vistula valley cut by many erosive defiles, rises in the landscape. The highland bordering the Vistula valley is rather flat, only slightly undulated. From the west, the ,,Ciechocinek Basin'' is bordered by the upper erosive terrace and covered by sand dunes and pine forests. The vicinity of this dry terrain is an important factor in the local climate of Ciechocinek. Here, the small valley of the river Tonczyna has a soaked character only.

The salt springs are the basis of the therapeutic properties of Ciechocinek and appear profusely on this area and on its surroundings in Jurrassic formation.

Rheumatism, diseases of the circulatory system, respiratory system and many others are some of the complaints treated in Ciechocinek and therefore, the study of the climatic conditions in Ciechocinek is of great importance because it has been suggested that the climate has a great influence on the therapy and the course of those diseases.

3. Observational material and the method of its elaboration

Detailed field investigations in Ciechocinek and its surrounding area were carried out for three years (1957-1959) during typical weather situations. These investigations were conducted mainly in the summer half of the year between May and October, i.e. when the therapeutic possibilities of the resort were fully exploited.

In 18 assigned spots, each representing a defined type of geographical environment, systematic observations of meterological elements were carried out during a period of 105 days. These observations were made at one hour intervals during the day and frequently during the nights as well. The re sults of these observations were used for computing the differences of the air temperatures, the air humidity and the wind speed between every point of measurement and the central meteorological station which represents the climatic conditions in the central part of the resort. These differences were calculated as mean deviations conducted in one chosen type of weather only. The weather typified by feeble nebulosity (0-2/10 parts of the sky covered, with an eventual increased cloudiness to 5/10 in the afternoon) and of calm and feeble winds (0-4 m/s.) was taken into consideration. During such weather the greatest differentation of effective temperatures can be observed as being the consequence of the unequal character of the ground surface.

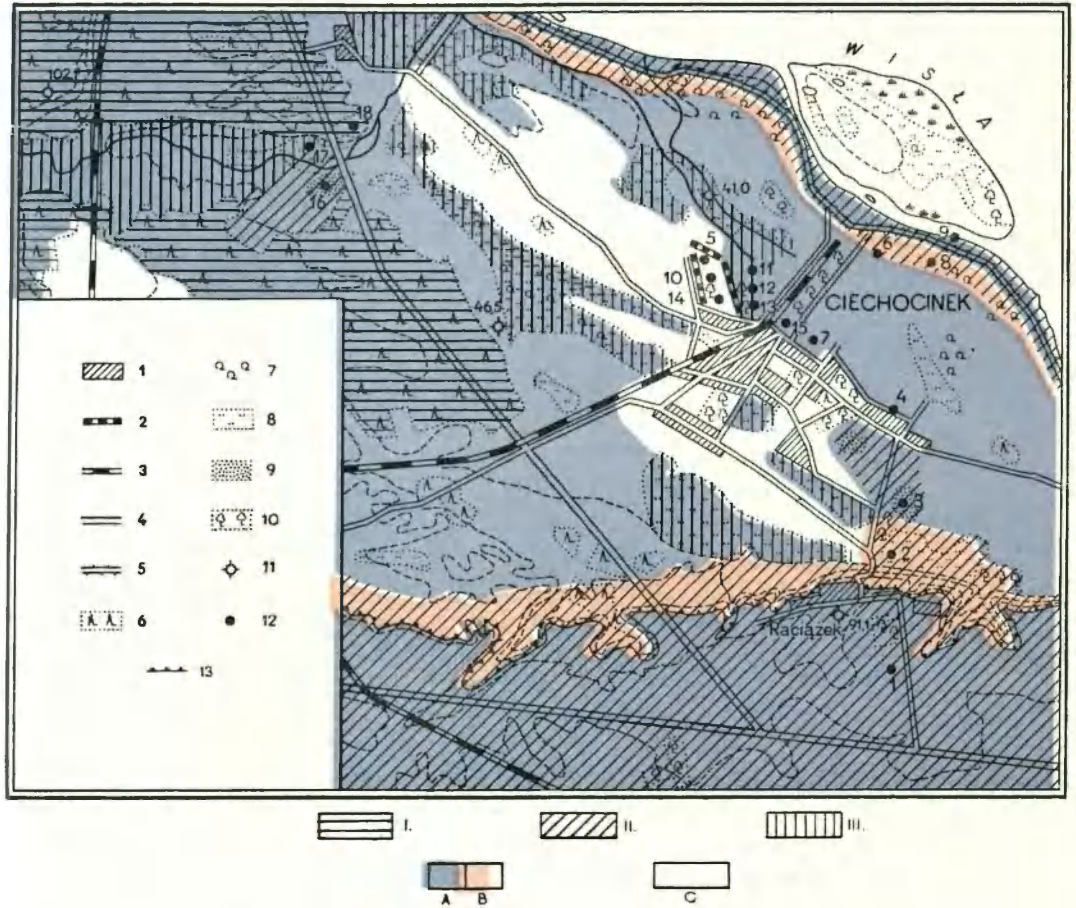

Fig. 1. Deviations of effective temperatures during the day

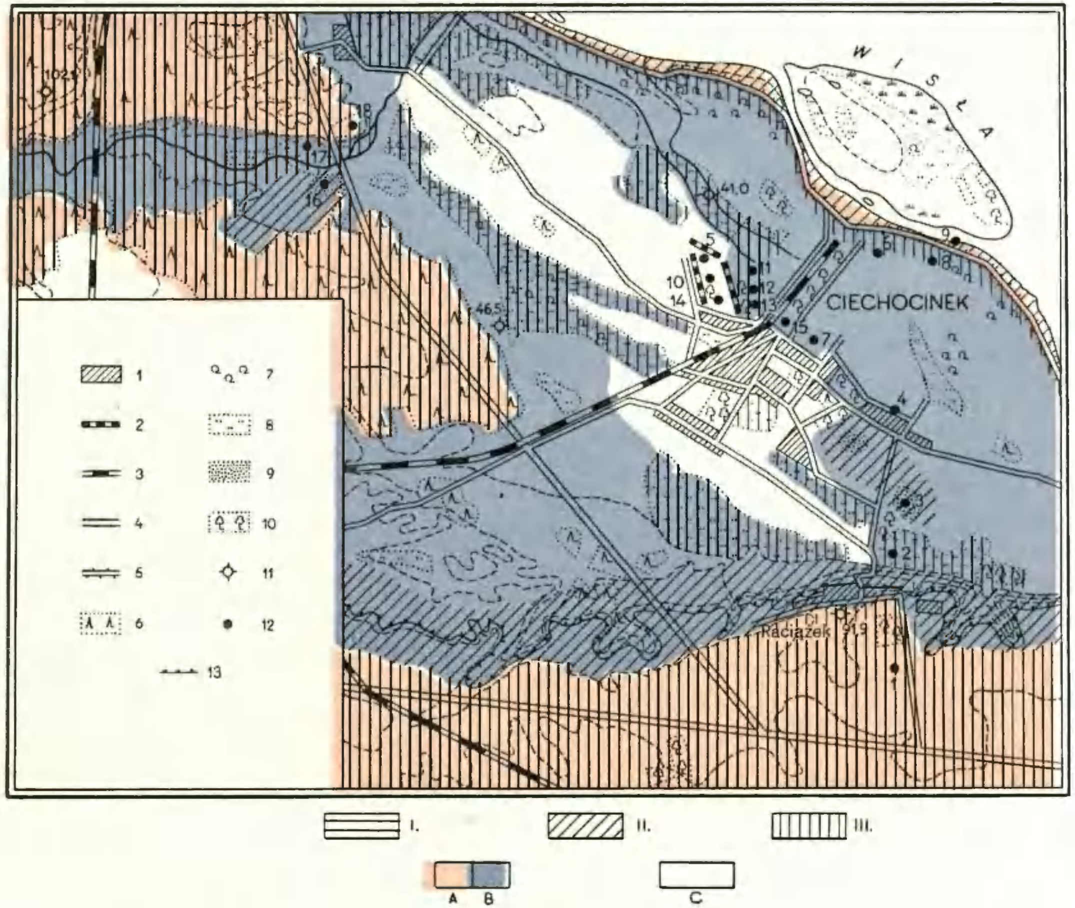

Fig. 2. Deviations of effective temperatures during the night

1 — built up areas, 2 — salt concentration plants, 3 — railways, 4 — roads, 5 — dikes and mounds, 6 — woods, 7 — bushes, 8 — meadows, 9 — sands, 10 — parks, 11 — elevation, 12 — observation points, 13 — edge. Temperatures influenc ed by: I — therm elements, II — humidity, III — wind. A — deviations of temperatures positive, B — deviations of temperatures negative, C — lack of deviations

The measured values of temperature, humidity and wind speed were then used for computing the effective temperatures at all the measurement points, using for this the scale of effective temperatures by C.P. Yanglou. This scale enables the computing of effective temperatures for wind speeds slighter than 3 m/s.

For greater wind speeds the diagrams prepared by G. Seifert were used.

These computations represent the starting point for plotting maps (Figs. 1 and 2) of the distribution of the effective temperatures on the investigated area.

The deviations of effective temperatures from the values in the central meteorological station having been found, maps were drawn seperately for the day and for the night. Separately also were designated the elements: temperature, humidity or wind, according to their significance on the formation of the considerable deviations of effective temperatures. The accepted boundary value was 4°C.

4. Results of the research

Having taken into consideration the results of the observations carried out on chosen days of the summer half of the year and represented in the form of maps of deviations of the effective temperatures (Figs. 1 and 2), we are now able to say that the wind-speed plays a considerable role in the distribution of effective temperatures during day hours. The elevated terrains, such as the highlands and dunes (point 1 and points 3, 16) are characterized by negative deviations. All depressions, such as the area lying under the ridges of the valley (point 2) and the river dam (point 8) have positive deviations. On the banks of the Vistula the deviations are negative on account of the increased wind-speed.

The air-temperature influences the formation of negative deviations on the area of moist meadows (points 11 and 17).

The element of air-humidity plays a marked role on the sandy areas. Here rather low values of relative humidity can be observed and therefore also low effective temperatures with deviations more than -4°C. (point 18).

During clear nights the air-temperature has the greatest influence on the distribution of effective temperatures. Positive deviations occur on account of higher air-temperatures, on the forest areas in the vicinity of Otloczyn (point 18) and on the highlands near Raciążek (point 1). Negative deviations are noticeable over all the ,,Ciechocinek Basin'' including the sandy areas.

The wind also affects the effective temperatures during clear nights, causing negative deviations on the edges of the Vistula valley as well as on the sand dunes within the valley. On the other hand, the influence of air-humidity on the effective temperature during the night is insignificant.

The next question to be solved is the role played by particular geographical factors in the formation of areal differentiation of the temperature, humidity and wind speed.

It can be proved after an intense analysis of the results of the field investigations that the relief has a decisive influence on the formation of local climatic conditions. The relief causes relatively great negative deviations of air temperatures during the day on the elevated parts of our area. Such conditions occur in point 1 where the deviations attain nearly 8°C.; on the other hand the positive deviations appearing in the dry depressions exceed 4°C.

During the night the relief is involved in the local advection of the cold air. For this reason, lower parts of the terrain are characterized by significant negative deviations to 4°C. (points 2, 8, 17). On the higher parts the deviations are positive (point 1), reaching 5°C.

The influence of the relief is practically unmarked on the distribution of relative humidity during the day but the elevated parts have negative deviations during clear nights (point 1). The relative humidity here is often more than 15% lower than in the centre of Ciechocinek (point 7).

The relief modifies in a high degree the wind-velocity. By day the greatest positive devations are observed on the highland to the south of Ciechocinek (point 1) attaining 4 m/s. The wind-speeds on the ridge and the slopes of the highland as well as on the slopes of the sand dunes are increased during the night, a fact connected with the downflow of cold air.

The climatic differentiation of the investigated area is also due to the vegetation-cover which is not of a homogeneous nature. Afforested areas are characterized by positive deviations of the air-temperatures both during the day and night, attaining 4°C. (point 18). On the moist meadows during the night can be seen the influence of the vegetation on the air-temperature. The differences in relation to the centre of Ciechocinek are great, sometimes reaching 6°C. (point 11, 17).

The park area by day is a little colder than the surrounding area, whereas at night it is warmer. These differences which do not exceed the boundary value, are comparatively negligible. The wind speed on the afforested area is smaller than in the centre of the resort. The differences do not exceed 2 m/s. during the day and at night vanish entirely.

Apart from relief and vegetation-cover, the differentiation of climatic conditions also is influenced by the physical properties of the ground, primarily by its heat-capacity and heat-conductivity. On fine summer days, sandy areas and frequently the dunes (points 3, 4) are characterized by rather high positive deviations of the air-temperature. The differences when compared with point 7 sometimes attain 10°C. The greatest negative deviations attained of 5°C. have been observed on the moist meadows (points 2, 11). The reason for this is that the high soil-humidity not only increases the heat-capacity but also to a certain degree the heat-conductivity . In the hours of the night, the dunes (points 3, 16) are characterized by negative temperature deviations, sometimes attaining 10°C.

The thermo-physical properties of the ground have an important influence on the relative air-humidity. The dunes and the other sandy areas both day and night possess negative deviations attaing 20% (points 3, 16). Even the forest areas on the sandy ground (point 18) have negative deviations of relative humidity up to 15%. On the soaked terrains were observed both night and day in clear fine weather positive differences attaining 20%.

The influence of the ground-character on the wind-speed is apparent during the day on the dunes (points 3, 16) when the increased wind-speed is due to thermal turbulence. These positive deviations of the wind-velocity exceed 4 m/s. in many cases. There is no marked influence of the ground-character on the differentiations of the wind-speed at night.

To a certain degree, an influence of the river Vistula on the formation of local climatic conditions may be observed. This influence is distinct in regard to the air-temperature, the deviations in the immediate neighbourhood of the river (point 9) are negative by day and positive by night, attaining 4°C.

The deviations of the relative humidity both by day and by night are here positive, attaining 15%, in comparison to the values on the central point.

The open water-surface favors the increase of wind-velocity. Here, therefore, the deviations of the wind-speed are positive day and night.

The climatic role of the river, clearly to be seen in the values of air-temperatures, air-humidity and wind-speed does not extend beyond the dam.

5. Final remarks

The results of the investigation presented here, enable us to delimitate the favourable and unfavourable areas from a bioclimatological point of view. The most favourable are the conditions occurring on the sandy afforested terrain to the west of Ciechocinek. This area is characterized on fine summer days, by moderate effective temperatures, whereas on clear nights the effective temperatures are much higher than those in the central part of the resort. The valley of Tonczyna is the one exeception here, the effective temperatures being both day and night lower than in Ciechocinek. Relatively favourable conditions reign over the highland to the south of Ciechocinek. Here the effective temperatures are lower by day and higher by night as compared to the centre. On the river Vistula also, the bioclimatic conditions are comparatively good.

The soaked meadows to the north and south of Ciechocinek are areas with unfavourable bioclimatic conditions, where both day and night the deviations of the effective temperatures are negative and where fog is frequent. Unfavourable bioclimatic conditions also reign beyond the river dam, where the effective temperatures are high by day and low by night.

The represented differentiations of effective temperatures, in regard to one type, namely the radiative type of weather, has been accepted as the criterion for appreciation of the climate of Ciechocinek.

The resulting aspects of this study enable us to acknowledge the climate of Ciechocinek and also they possess a general value in the explanation of relations between the character of the Earth's surface and meteorological parameters.

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THE WATER BALANCE OF A HIGHLAND AREA OF CRETACEOUS MARLS ILLUSTRATED BY THE EXAMPLE OF THE UPPER SZRENIAWA RIVER BASIN

IRENA DYNOWSKA

The water balance of any area is closely related to the nature of its geographical environment. Thus the evolution of the particular elements that make up the water balance of a given terrain is influenced by its topography, plant-cover, soil and geological structure. The aim of the present paper is to discuss problems concerning the water balance relations in a highland area built of Cretaceous marls. Detailed field investigations in the upper Szreniawa river basin show that the water regime within an area of this type is of considerable interest. Its noteworthy features are a markedly slow but uniform surface run-off, the escape of water from the river channel into the underground waters of the neighbouring drainage area, and the strong retention capacity of the rocks.

PRELIMINARY REMARKS ABOUT THE UPPER SZRENIAWA RIVER BASIN

The Szreniawa is a left-bank tributary of the Vistula. The area covered by the upper portion of its basin here under consideration is 264.4 km²; it lies within the Plateau of Miechów and Kraków (Fig. 1). The Plateau, c. 280-480 m a.s.l., gently slopes to the SE and is dissected by a dense network of short, deeply incised valleys, of up to 100 m in depth.

The predominant soils are fertile loess soils and those of the *rhendzina* type, and as a result this is essentially an agricultural area. About 90% of the area is under cultivation, while small woods scattered throughout the area occupy an additional 5%.

The mean annual precipitation is 635 mm. Rainfall is more abundant on the western peripheries of the area than in the southeast, which lies to the lee side of the plateau. Precipitation is highest in summer, and lowest in winter.

In the west the plateau is built of Jurassic rocks, consisting mostly of marly platy limestones; the remaining area is made up of Cretaceous marls, generally covered with loess, while the valley bottoms are covered with poorly permeable alluvia.

The lithological development of the Cretaceous marl lacks uniformity. This is a calcareous rock containing a varying admixture of clayey and siliceous parts. In their water conductive properties, marls with a low clay content

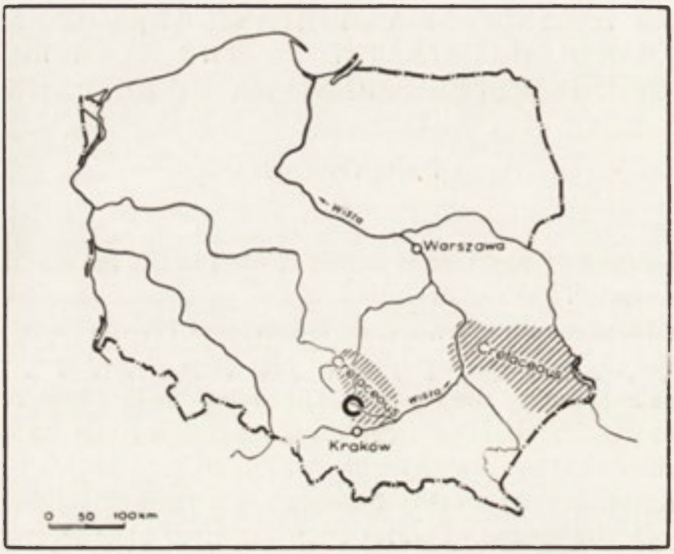

Fig. 1. Situation of the upper Szreniawa basin

resemble limestones but owing to their numerous interstices they are water-bearing. The clayey marls on the other hand have fewer interstices because of the lubrication of the smaller interstices, and marls thus developed are impervious. The marl with a high silica admixture is another facial type, and it is this facial differentiation of the Cretaceous marls, both in the vertical and horizontal section, that is the decisive factor controlling the ground water regime.

The Mesozoic sediments here generally have an eastward dip of 2-7°.

Material

A solution of the above problems was attempted with the aid of detailed investigations and measurements carried out by the author in the years 1956 to 1958. These studies included hydrographic mapping, and measurement of ground waters, in about one thousand wells, of the water yield of all the springs (73) in this area, and of the water flow of the Szreniawa and its tributaries.

Underground waters

The characteristic traits of a marly basin are the deep position of the underground water table, and the presence of several superimposed water tables. The depth of the water table indicates that the ground-water table does not, on the whole, follow the surface configuration of the terrain but develops independently. This is due to the great number of interstices in the marl

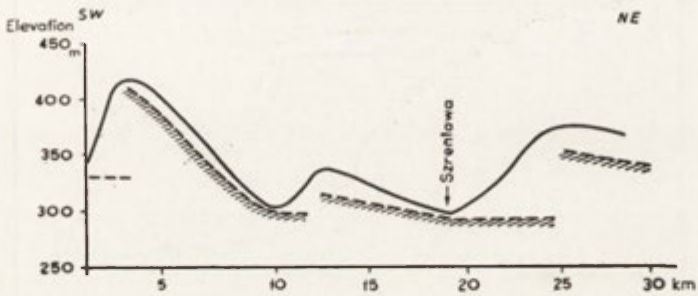

Fig. 2. Imbricated arrangement of the subsurface water levels in a monoclinic area

layer. The water horizons were determined by measuring the depth of the ground-water level in wells. The distance between them varies but may reach up to 60 m.

The occurrence of the water horizons is connected with the geological structure. The presence of several superimposed water horizons is caused by the alternation of fissured water-bearing and compact, impervious layers.

When analysing the distribution and position of the underground water in the basin drained by the upper Szreniawa and in the neighbouring areas, an "imbricated" arrangement can be observed. This arrangement consists in the regularity of the underground water horizons which begin within the dividing ridges and whose dip follows the conformable bedding of the slope. Within the watershed ridge the water horizons strike one below the other (Fig. 2).

In the valleys the ground-water table occurs either above or below the river channel. The former is responsible for the river drainage of the groundwaters. Springs feeding the stream with water, occur along these zones.

Springs with a high and fairly stabilized water yield indicate rich groundwater resources within a marly basin. The total yield from all the springs is 990 l/s. The majority of springs represent slope base springs and they are situated at the point of contact of the permeable marls with the poorly permeable alluvia.

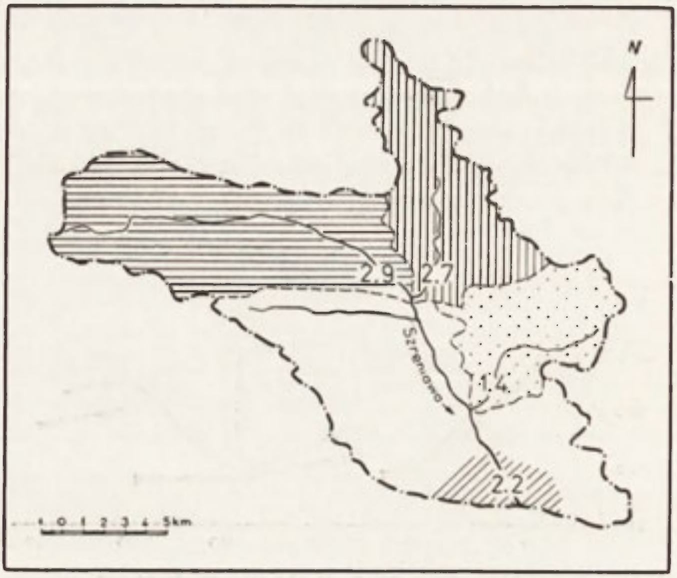

Fig. 3. Amount of unit flow (1/sec/km²) of the Szreniawa and its tributaries in 1956/57

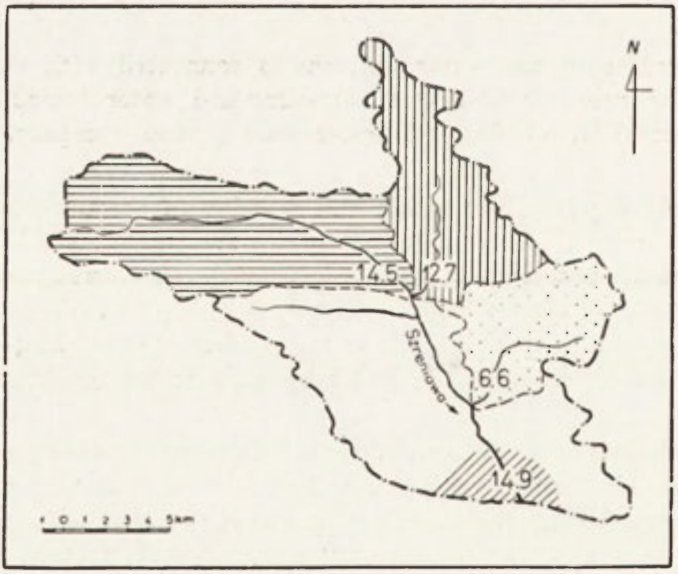

Fig. 4. Value of the flow coefficient (%) of the Szreniawa and its tributaries in 1956/57

Observations show that over relatively long distances the ground water table in the valley occurs as much as 8 m below the water level in the river channel. This may be explained by the isolation of stream water by the poorly permeable deposits in the stream channel. This marked difference between the stream water level and the ground-water table favours the escape of water from the stream channel into the deeper substratum.

Water outflow

The reserves of the surface water are extremely scarce. The constant river network is not dense. The river regime of this area may be defined as a combination of the spring-rainfall-thaw type. It is characterized by fairly stabilized water levels, and a fairly constant flow during the rainless or low precipitation seasons, while during downpours or at thaw-time the high and low water mark is subject to sudden diurnal changes. This type of river regime is associated with a uniform subsurface-water supply during rainless and low precipitation seasons, thus proving the strong retention capacity of the region under consideration. On the other hand the configuration of the river basin (numerous gorges and canyons) favour surface run-off during violent downpours or at thaw-time.

The Szreniawa and its tributaries are characterized by a strikingly low unit flow. The mean annual unit flow for the period between 1956 and 1960 ranged from 2.0 to 4.7 $l/s./km^2$, the average figure for that period being 3.2 $l/s/km^2$. Still lower values have been noted in particular catchment areas. Daily observations were recorded here only during one year (1956-1957). The unit flow values for that period are shown on a sketch map (Fig. 3). A relatively abundant unit flow was observed in streams flowing to the east, i.e. in a direction consequent with the dip of the rock layers, while in those flowing to the west, i.e. in an obsequent direction, the volume of flow was very low.

The flow coefficient was also extremely low, being 10-20%, or an average of 16.8% for the five-year period 1956-1960. In the tributary streams these values were lower too, as was observed in 1956-1957 and is shown on another sketch map (Fig. 4).

These low flow values may be accounted for by the escape of water from the river channel, in accordance with the dip of the rock layers directly into the neighbouring catchment area without supplying water to the streams (Fig. 5).

The amount of water escaping from the river bed is calculated by the difference between the total yield of all the springs and the volume of flow of water in a rainless season with respect to a unit area. When calculating the amount of the subsurface-water supply it was assumed that the total water flow in the river bed during a rainless season comes from a subsurface water supply.

The relation of the total yield of all the springs to the area of the river basin is defined by the author as the unit yield per l/s./km². The sketch map in Fig. 6 shows the unit yield of the springs for the particular catchment areas and their unit flow values in rainless seasons.

From the differences between these two values can be determined the uncontrolled amount of subsurface water supplied directly to the river channel,

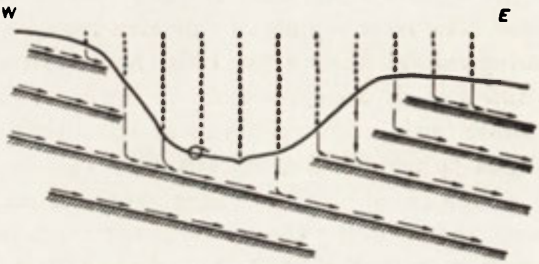

Fig. 5. Section showing the water flow beyond the Szreniawa basin without water supply into the river channel

or else the amount of water that escapes from the given catchment basin. In the area here considered the balance of the subsurface water supply is a negative one. The total yield of the springs amounts to 990 l/s. while the flow is hardly 564 l/s. This shows that 57% i.e. more than one half of the river water escapes from the river channels into deeper substratum. In relation to the area, the yield of all the springs is 3.7 l/s./km² while the flow is hardly 1.6 l/s./km². Hence in the upper Szreniawa basin more than 50% of spring water escapes from the river channel.

Reliable evidence of the amount of water escaping from the river channel into deeper strata is provided by the comparison of the mean annual river flow (by means of measurements of the flow in the tributary streams) with the results computed by empirical formulae. These are as follows:

	mean flow m^3/s	unit flow $l/s/km^2$	flow coefficient %
Results of empirical formulae	1.5 — 1.8	5.9 — 6.8	30 — 35
Results of measurements	0.8	3.2	16

The results obtained by empirical formulae exceed by 100% the true waterflow. This agrees with the calculated amount of the loss of water from the river channel, showing that 50% of the stream water escapes from it. Hence, empirical formulae should not be used to determine the water balance of areas with similar physiographic conditions.

Geology has a strong bearing on the water circulation of a given region. Owing to the numerous interstices in the marls the subsurface retention capacity is markedly high, which in turn contributes to a well balanced river regime during low precipitation seasons. The relatively permeable soils and the extensive flat highland inliers facilitate the seepage of rain water and

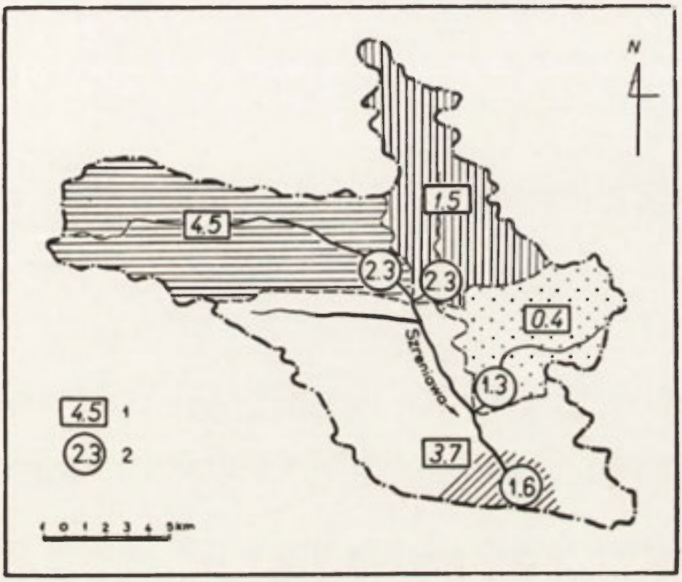

Fig. 6. The unit yield of springs (1) and the unit flow (2) per l/sec/km²

the supply of subsurface water resources, whereas downpours or sudden thaw water is quickly lost through surface run-off. This rapid run-off is favoured by the plateau being broken up into numerous young valleys and by the lack of larger wooded tracts capable of retaining the water.

The strikingly low flow values are due to the escape of water into lower strata and beyond the river basin. This escape of water is made possible by the monoclinal tectonics, the lithological differentiation of the marl and the consequent occurrence of subsurface water in the overlying horizons.

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DIVISION DE LA VOIVODIE DE LUBLIN EN RÉGIONS NATURELLES HYDROGÉOGRAPHIQUES EN VUE DE L'AMÉNAGEMENT DU TERRITOIRE

TADEUSZ WILGAT

INTRODUCTION

L'exploitation rationnelle des ressources hydriques constitue l'un des problèmes de base de l'économie moderne. Sa nécessité apparaît avec d'autant plus d'acuité que la situation hydrologique d'un territoire donné se présente sous un jour plus défavorable. L'aménagement adéquat des ressources hydriques exige la connaissance de la situation hydrogéographique en tous se-aspects. A cette fin, il faut résoudre trois problèmes. Le premier, qui constitue d'ordinaire le point de départ de tout plan d'aménagement, est l'évaluation du bilan hydrologique de la région sous examen. Le second consiste à caractériser qualitativement la situation hydrologique. Parfois sous-estimée, cette caractérisation devrait former la base de toute étude; suffisamment approfondie et compréhensive, elle permet en effet de dégager les lignes directrices d'une politique de l'eau, conforme aux principes de la protection des ressources naturelles. La troisième tâche, c'est la régionalisation hydrogéographique, délimitant les unités territoriales naturelles pour les besoins de la planification de l'aménagement hydrologique.

Jusqu'ici on acceptait comme unité de base pour l'aménagement hydrique le bassin de drainage d'une rivière. Dans les cas où l'on créait des régions hydrographiques, on se contentait simplement de subdiviser les bassins les plus étendus ou de grouper ensemble plusieurs bassins de moindre importance. Une telle façon de procéder est justifiée en ce sens que, prenant pour base les bassins ou leurs groupements, on peut calculer le bilan hydrologique par la méthode classique. Souvent cependant les basssins ne recouvrent pas des aires aux caractéres hydrographiques semblables ou ne coincident pas avec les régions hydrogéologiques, ce qui rend difficile la planification de l'aménagement du territoire. Le plus commode serait d'opérer avec les unités territoriales à situation hydrologique uniforme et à bilan d'eau évalué. La région hydrogéographique est à même de remplir ces conditions. Son homogénéité découle de son principe même; quant à son évaluation quantitative, nous pouvons l'obtenir, pour nous en tenir à la méthode classique, au moyen d'indices d'écoulement, de débits unitaires et de coefficients d'écoulement, calculés pour les bassins entrant pour tout ou partie dans la composition de la région.

Principes methodologiques généraux

Le régime hydrologique dépend en premier lieu de la quantité d'eau mise en circulation, et donc des précipitations et des pertes par évapo-transpiration, autrement dit, de facteurs climatiques. Quelle quantité de l'eau fournie ruissellera directement sur la surface du sol, et quelle quantité s'infiltrera, cela dépend déjà des conditions du terrain: relief, structure géologique, sol, couverture végétale, et bien sûr aussi, de l'action variée de l'homme. Chacun des facteurs mentionnés influe sur les voies et la vitesse de la circulation de l'eau. Ces influences combinées donnent en résultat une différenciation énorme dans l'espace de la situation hydrologique. Pour délimiter les unités hydrogéographiques, il est donc nécessaire de procéder à l'analyse de cette situation. Elle permet de déterminer les caractères qui individualisent un territoire de la manière la plus marquée. Ils ne sont pas identiques pour tous les terrains et leur choix doit découler de l'analyse. Deux principes pourtant semblent indiscutables dans tous les cas. En premier lieu, il faut prendre en considération tant les eaux de surface que les souterraines; elles restent en effet en étroite interdépendance et leur étude conjointe est fondeé du point de vue scientifique aussi bien que de la pratique. En second lieu, dans le choix des caractères distinctifs, il faut tenir compte de ceux qui reflètent les différences statiques dans les régimes comme de ceux qui caractérisent la dynamique de la circulation de l'eau. Le choix des caractères est fonction aussi de l'état de l'analyse et de la qualité des matériaux de base.

Materiaux

Dans le cas de la voïvodie de Lublin, les matériaux au départ sont constitués par: a) les observations du service hydro-météorologique, b) la documentation hydrogéologique relative aux forages de puits, c) le levé hydrographique détaillé exécuté par les géographes [2.7].

Le levé hydrographique embrasse les eaux de surface aussi bien que les eaux souterraines. Grâce à son caractére détaillé et compréhensif, il fournit des matériaux irremplaçables pour la détermination des caractéristiques hydrogéographiques. Le levé a déjà été tracé pour 8600 km² de la voïvodie, soit

1/3 de son étendue. On n' aura de base complète pour une synthèse hydrogéographique que par le levé de la superficie totale de la circonscription. Dès à présent cependant, on peut tenter une présentation synthétique des conditions hydrologiques et leur régionalisation.

Methode de delimitation des regions hydrogeographiques

Sur la base de l' analyse de la situation hydrologique dans la voïvodie de Lublin on a choisi 9 marques qui, semble-t-il, caractérisent d' une manière suffisamment globale cette situation et les différences territoriales. Ces caractères sont les suivants:

1. total des précipitations annuelles,
2. genre de roche aquifère et caractére des eaux souterraines,
3. grandeur de la pression piézométrique des eaux souterraines,
4. rendement unitaire des puits,
5. profondeur jusqu'à la nappe d'eau souterraine,
6. densité et genre du réseau hydrographique en surface,
7. fréquence d'apparition et débit des sources,
8. régime des rivières,
9. écoulements unitaires.

On n'a tenu compte que d'un seul facteur climatique car le climat ne différencie les conditions hydrologiques que dans une faible mesure. La raison en est que la voïvodie, malgré sa grande étendue, 24 829 km², ne présente que de faibles écarts hypsométriques (points extrêmes: 110 et 390 m au-dessus du niveau de la mer) et partant un climat assez uniforme. Il n'y a de différences sensibles que dans le total annuel des précipitations. Aux chutes faibles, moins de 550 mm, dans la partie nord-est de la voïvodie s'opposent les chutes plus abondantes, plus de 700 mm, dans la partie sud-est, la plus élevée. L'influence des autres éléments du climat s'efface en présence des facteurs qui modèlent bien plus nettement le régime: structure géologique, relief et action de l'homme.

Quatre caratères ont trait aux eaux souterraines. La grande place accordée à ces dernières se justifie par le fait qu'en un terrain aussi pauvre en eaux de surface, qu'est la voïvodie de Lublin, elles sont d'une importance majeure. Les eaux apparaissent dans les roches compactes du crétacé comme fissurales ou, plus souvent, comme nappes fissurales (nous appelons ainsi en Pologne les eaux existant dans les roches fortement fissurées, séparées par des couches peu perméables [6]). Elles se rencontrent aussi dans les formations lâches du quaternaire ou du tertiaire. Le genre de roche aquifère et le caractére des eaux sont donc d'importants facteurs de différenciation. Comme seconde marque distinctive on a accepté la grandeur de la pression piézométrique car, dans la voïvodie, on trouve aussi bien des eaux libres que des nappes captives, généralement subartésiennes, exceptionnellement artésiennes. Le troisième caractère, c'est le rendement unitaire des puits, pour suppléer le défaut d'évaluation de la richesse des nappes. Enfin, on a pris en considération la profondeur jusqu'à l'eau, extrêmement variable à l'intérieur de la voïvodie et importante du point de vue pratique.

Les quatre autres caractères se rapportent aux eaux de surface. Il a été tenu compte avant tout de la densité du réseau hydrographique, élément le plus apparent et présentant de vifs contrastes dans la voïvodie. On a considéré à ce propos le caractère des cours d'eau et des réservoirs naturels et artificiels. Autre élément important pour la régionalisation hydrogéographique de la voïvodie, les sources présentent aussi une grande variété quant au site, type et débit. Les rivières ont été caractérissées par l'évaluation, pour toutes les stations hydrométriques en possession d'observations suffisantes, des coeffi-

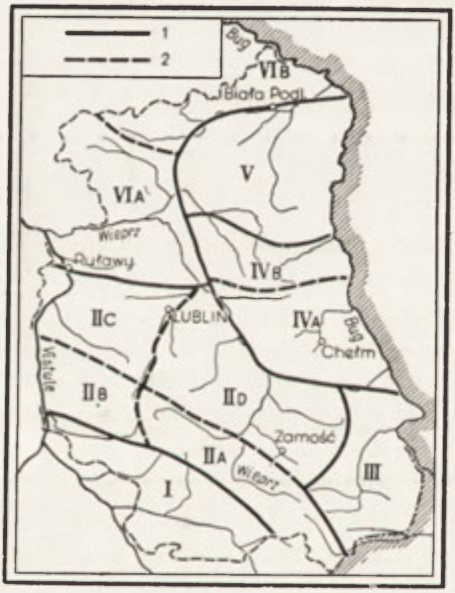

Fig. 1. Régions hydrogéographiques de la voïvodie de Lublin
1 — Limites des régions, 2 — Limites des sous-régions.

cients d'écoulement. Les régimes, il est vrai, ne présentent pas de différences radicales, celles qui existent néanmoins ne sont pas sans importance pour l'économie. Le dernier caractère est constitué par les écoulements unitaires moyens qui caractérisent jusqu'à un certain point les bilans.

Comme matériaux de contrôle on a utilisé de plus la carte des excédents et des déficits d'eau, calculés par K. Wojciechowski par la méthode de Thornthwaite et Mather[1].

[1] Ces évaluations ont été présentées par l'auteur en janvier 1963, à la conférence consacrée à l'aménagement des ressources hydrauliques de la voïvodie de Lublin.

Sur la base de chacune des caractéristiques précédentes on a divisé la superficie de la voïvodie en plusieurs parties (de 4 à 7), selon le degré de différenciation d'une caractéristique donnée. Les limites ont été tracées d'une manière plutôt schématique car, dans la réalité, elles, se présentent le plus souvent non comme des lignes mais comme des bandes plus ou moins larges. Aux parties ainsi distinguées on a appliqué de préférence les désignations proposées par Chałubińska et Wilgat en 1954, pour la division physiographique de la voïvodie [1].

Ayant procédé ainsi à 9 partages successifs, on a fait la liste de toutes les désignations obtenues. Certaines se répètent, ce qui veut dire que des régions données se distinguent plus fortement et peuvent être tenues pour régions hydrogéographiques autonomes. C'est ainsi par exemple que la plaine de Sandomierz apparaît comme unité distincte dans tous les partages. La partie orientale du Plateau de Lublin revient 5 fois, et la partie nord de la Polésie de Lublin 4 fois. D'autres unités apparaissent en connexion avec les unités voisines, pas toujours les mêmes du reste. La fréquence d'apparition, séparée ou en connexion, des unités distinguées, constitue la base pour la délimitation des régions et sous-régions hydrogéographiques.

En fin de compte on a obtenu le partage de la voïvodie en 6 régions hydrogéographiques, subdivisées en unités plus petites, au total de 11 (voir carte). Les limites des régions ont été tracées, là où c'était possible, le long de lignes physiographiques nettes. A défaut, on a pris comme limite, pour des raisons pratiques, les lignes de partage des eaux. On a évité par contre, dans la mesure du possible, de fixer les limites le long des rivières.

Caractere des regions hydrogeographiques

La région I coïncide avec le fragment de la plaine de Sandomierz qui fait partie de la voïvodie de Lublin. C'est une dépression subcarpathique comblée par une épaisse série de dépôts miocènes, surtout argiles. Des formations quaternaires en recouvrent la surface. Des dunes introduisent un élément de variété dans le relief plat de la plaine. L'existence de formations imperméables à peu de profondeur donne à cette région un réseau hydrographigue serré. Il y a de nombreux marais et étangs. On rencontre partout, dans les dépôts quaternaires, des nappes superficielles communément utilisées par la population. Les eaux profondes, subartésiennes, sont pauvres et d'accès dififcile, d'où grande difficulté dans l'approvisionnement de la population en eau potable de bonne qualité. Les rivières sont petites mais assez abondantes. Les écoulements unitaires sont supérieurs à la moyenne de la voïvodie (3,6 l/sec/km^2) mais très variables dans le temps. L'été apporte la pénurie d'eau surtout dans l'exploitation des étangs.

Les régions II et III couvrent le Plateau de Lublin avec une chaîne de faibles hauteurs dite Roztocze [5]. Sous le rapport tectonique c'est un bassin crétacé, fragment du Bassin Danois-Lwowien. Sa structure est simple et ce n'est que dans la périphérie sud-ouest qu'apparaissent des troubles anticlinaux. La lithologie est plus variée. Les dépôts crétacés y ont l'aspect d'*opokas*, de marnes de craie, de gaizes et de calcaires. Sur ces dépôts se sont conservés débris de formations tertiaires ainsi qu'une couverture pléistocène discontinue, surtout des loess, occupant de grands espaces, et des formations alluviales qui remblaient les vallées de rivières profondément taillées dans le sous-sol crétacé. Les eaux souterraines apparaissent principalement dans les roches crétacées: il s'agit d'eaux fissurales ou, le plus souvent, de nappes fissurales; ces dernières forment des couches superposées, les nappes supérieures étant d'étendue et de capacité moindres que celles plus profondes, qui constituent la principale source d'approvisionnement en eau pour la population.

A la région II appartiennent le Roztocze et les parties occidentale et centrale du Plateau de Lublin. Le réseau hydrographique y est le plus lâche de la Pologne. Il y a des endroits où l'eau la plus proche est distante de plus de 6 km. Les rivières sont peu nombreuses et peu abondantes. La plus grande, le Wieprz, roule 18,5 m^3/sec d'eau en quittant le Plateau. Les écoulements unitaires cependant, grâce au pouvoir de rétention élevé du substratum, dépassent ceux du reste de la voïvodie et présentent le moins de variations saisonnières. Les sources nombreuses se groupent surtout dans les vallées de rivières. Le débit des plus fortes dépasse 6 m^3/min. Il n'est pas rare non plus que les puits donnent un débit élevé. Ce phénomène est lié à la facilité d'infiltration de l'eau par les fissures et à la grande capacité de certains réservoirs souterrains. Les eaux souterraines apparaissent souvent à de grandes profonsdeurs (plus de 50 m). Aussi les agglomérations situées loin des vallées de rivières éprouvent-elles de la difficulté à s'approvisionner en eau. Bien des fermes, et même des hameaux entiers ne possèdent pas de puits; leur population doit transporter l'eau à partir de sources éloignées. L' extension de la zone d'habitation aux hautes terres et le percement de nombreux puits exploitant les nappes supérieures pauvres en eau, comme aussi le déboisement, ont entraîné une aggravation marquée des conditions hydrographiques, ce qui se reflète dans la disparition de sources et de secteurs supérieurs de rivières, l'appauvrissement des nappes d'eau souterraines, l'accroissement de l'érosion du sol et de l'accumulation dans les fonds des vallées.

Malgré une ressemblance foncière, les sous-régions formant la région II présentent cependant entre elles des différences. Le Roztocze dispose des plus grands surplus d'eau. C'est en même temps le territoire qui possède le réseau de surface le plus lâche et les eaux souterraines les plus profondes. La profondeur des puits creusés dépasse même 80 m. Dans la partie sud-ouest du Plateau de Lublin (sous-région B), une structure géologique compliquée fait que les conditions hydrogéologiques sont plus complexes que dans les autres parties. Le secteur nord-ouest (sous-région C) s'écarte le plus des autres par les profondeurs variables et souvent très réduites du plan d'eau. Le centre du Plateau (sous-région D) a toutes les caractéristiques-types de la région. C'est ici que les nappes fissurales supérieures se sont le mieux conservées. Dans les deux sous-régions septentrionales (C et D), la pénurie estivale d'eau se fait sentir plus fortement que dans la partie méridionale.

La région II est celle qui offre les plus grandes possibilités dans la voïvodie pour la mise à profit des excédents de printemps. Le problème spécifique est ici d'empêcher les modifications défavorables des conditions hydrologiques par la réduction de l'écoulement superficiel en faveur du renforcement des réserves souterraines. La lutte contre l'érosion du sol est aussi une question importante.

La région III, comprenant la partie orientale du Plateau de Lublin, a comme le reste du Plateau, des eaux souterraines principalement dans les formations crétacées. Elles sont cependant plus superficielles et moins abondantes. La région se distingue par des écoulements unitaires minimes. Les rivières forment un tissu serré mais appartiennent aux plus pauvres en eau de la voïvodie. Les besoins hydriques de cette région ne peuvent être couverts par les ressources propres.

La région IV embrasse la zone de transition entre la bande des hauteurs et la plaine. Elle est caractérisée par l'alternance d'élévations crétacées et de bas-fonds plats et humides; en conséquence, les eaux souterraines se rencontrent à des profondeurs variables. Elles apparaissent dans les formations crétacées et dans les dépôts lacustres pléistocènes remblayant les creux. La densité du réseau hydrographique est aussi variable. Peu de sources. Par contre, on rencontre communément des *dolines* karstiques de toute dimension, remplies d'eau en permanence ou par intermittence. La sous-région B groupe près de 70 petits lacs d'origine karstique [3]. Les écoulements unitaires sont inférieurs à la moyenne de la voïvodie et varient sensiblement dans le temps. L'exploitation des ressources hydriques exige une attention particulière car les conditions hydrographiques sont compliquées et les excédents et déficits temporaires très variables dans l'espace.

Les régions V et VI occupent la plaine de la partie nord-ouest de la voïvodie. Sur ce territoire les roches crétacées s'enfoncent vers le nord sous des formations tertiaires de plus en plus jeunes, sables, limons et argiles. Toute cette étendue est couverte de dépôts quaternaires: glaciaires, fluvio-glaciaires, lacustres, fluviaux et organiques. L'on rencontre partout dans ces formations des eaux souterraines à faible profondeur et de mauvaise qualité utilisée cependant par l'ensemble de la population rurale. Les eaux plus profondes, des formations tant quaternaires que tertiaires et crétacées, existent en nappes captives sous pression. Les débits des puits sont peu élevés.

La région V occupe la partie nord de la Polésie de Lublin. Ce territoire se distingue par la plus grande proportion de terrains humides en permanence ou temporairement. Les eaux de surface y forment le tissu le plus serré de la voïvodie. Les écoulements spécifiques sont chétifs et très variables en cours d'année. Il y a excédent d'eau au printemps car les eaux de fonte nivale peuvent difficilement s'écouler sur le terrain plat et l'infiltration est rendue malaisée par les limons peu perméables recouvrant de grandes surfaces. Dès juin par contre l'on ressent une pénible pénurie d'eau. Les eaux souterraines superficielles sont impures, les eaux profondes peu abondantes. D'où la difficulté d'assurer à la population une eau potable saine. Au premier plan des problèmes hydrologiques de la région il faut placer celui de la régularisation des conditions dans les prés qui souffrent d' excédents et de déficits saisonniers d'eau.

La région VI diffère de la Polésie de Lublin par une proportion nettement moindre de terrains humides, un réseau plus lâche des eaux de surface et de plus grands écoulements unitaires. La division en sous-régions est dictée par le système du réseau fluvial. Dans la sous-région A, les rivièresco nvergent concentriquement vers le Wieprz qui les collecte; c'est la plus grande rivière de la voïvodie et son aménagement est le principal problème économique de la région. Les rivières de la sous-région B font partie du bassin du Bug.

Conclusion

Comme il ressort de ce passage en revue, certains problèmes hydrologiques se répètent dans diverses régions. Ainsi p.ex., la question de la pénurie saisonniére d'eau se pose dans toute la voïvodie, avec une acuité variable cependant, bien plus faible dans les régions méridionales que dans le nord et l'est. Les possibilités d'y remédier sont aussi tout autres: les régions I et II, et en particulier II A, peuvent y faire face à l'aide de surplus locaux; La sous-région VI A peut profiter de l'eau du Wieprz; les autres régions ont des excédents saisonniers trop réduits pour combler les déficits, ce qui entraîne la nécessité d'amener l'eau de l'extérieur. Dans l'ensemble de la voïvodie existent aussi des difficultés dans l'approvisionnement de la population en eau potable. Dans la région II elles ont pour cause la grande profondeur d'apparition de l'eau souterraine; dans les autres régions il s'agit de la mauvaise qualité des eaux souterraines superficielles.

Les régions particulières ont aussi leurs propres problèmes: La région II, p.ex., celui de la lutte contre l'érosion du sol, la région IV B, la mise à profit des lacs, les régions I et IV, l'exploitation des étangs. Elles offrent aussi diverses possibilités d'aménagement du point de vue de la situation hydrologique, plus ou moins favorable à l'implantation d'industries, à la planification du réseau d'habitation, à la pisciculture, à la création de centres de repos et de tourisme et dans d'autres domaines.

Pour ces raisons la division en régions hydrogéographiques peut faciliter une planification appropriée de l'exploitation des ressources hydriques et constituer une aide importante dans l'élaboration des plans régionaux d'aménagement les plus adéquats.

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WATER BALANCE IN A HIGH-MOUNTAIN REGION ILLUSTRATED BY THE EXAMPLE OF THE WESTERN TATRA MTS.

ZOFIA ZIEMOŃSKA

In order to understand the water circulation and balance in mountainous drainage basins hydrographical researches were carried out in the Czarny Dunajec river basin (Western Tatra Mts.) during the period 1953—1958. This basin includes: high-mountain regions (over 1500 m a.s.l.) of glacial relief, built of crystalline rocks, high-mountain regions with fluvial and karstic relief, built of calcareous and dolomitic rocks, and middle-high mountain regions (less than 1500 m a.s.l.) of fluvial relief, built of calcareous-dolomitic, and shaly rocks. The Western Tatra Mts. have a geological structure similar to that of the Alps with a crystalline core and a cover of Mesozoic sedimentary rocks. Their relief and geological structure, as well as vegetation cover and climatic conditions are strongly diversified.

Owing to the considerable differentiation in the particular elements of the geographical environment in the Czarny Dunajec basin different conditions of development of water circulation and balance prevail there. Hydrographic researches carried out in this region aimed at detecting the principles of water circulation in a mountainous region of varying relief, built of rocks of differing permeability. For this purpose, in the years 1953-1955 a detailed hydrographical map of the river basin was constructed [4]. The task consisted in recording and localizing on a topographic map the largest possible number of indications of water circulation. The hydrographical map was made using only single sets of observations and measurements, concerning both surface and ground waters. This map served as a basis for selecting in particular regions of differing relief and geological structure hydrographical objects, which in the years 1955-1958 were constantly and systematically examined at different seasons of the year under different weather conditions. Altogether 90 measurements of discharge on streams, 195 measurements of groundwater table (wells), and 1600 measurements of springs were made. The hydrometric data of the Polish and Slovak Hydrological Service were utilized as well.

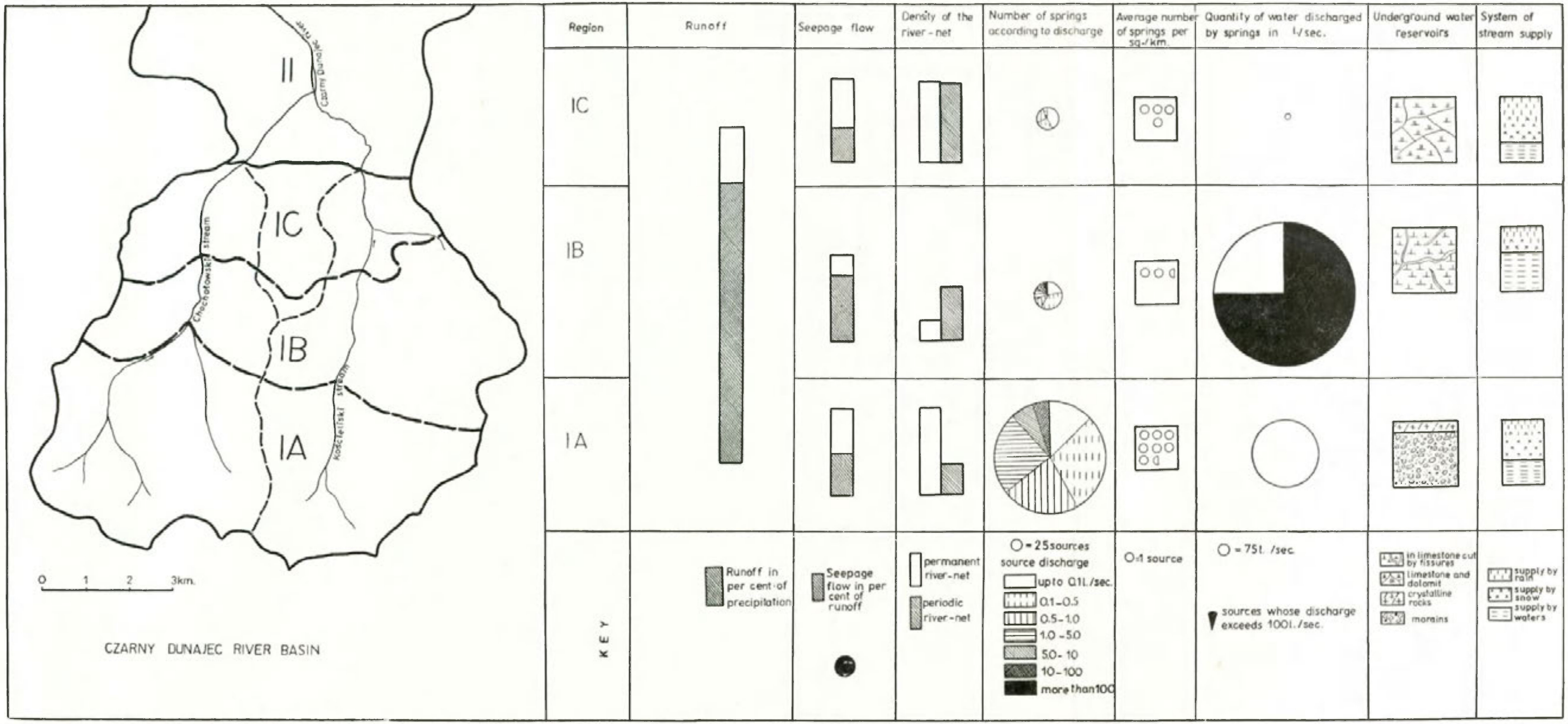

Fig. 1. Characteristics of the hydrographic regions

I) the Tatra region, representing a high-mountain river basin, with a run-off coefficient exceeding 0.70,

II) the Podhale region, representing a middle-high mountain river basin with a run-off coefficient between 0.55 and 0.70.

The diversity of the run-off and retention capacity ratios, particularly the difference in the magnitude of the subsurface water supply and in the development of the river system, made it possible to distinguish within the region of the Tatra Mts. smaller hydrographic units (or subregions). These are:

IA) the high-mountain crystalline-morainic subregion of glacial relief, characterized by a coefficient of ground surface run-off ranging from 0.40 to 0.50, and by the predominance of a permanent over periodical river system,

IB) the high-mountain calcareous-dolomitic (Karst) subregion with a coefficient of ground surface run-off amounting to 0.70, and a periodical river system prevailing over the permanent one,

IC) the middle-high mountain dolomitic-shaly subregion with a coefficient of ground surface run-off not exceeding 0.40, and a balance between the permanent and periodical river systems.

The division into regions and the characteristics of each of them are shown in the diagram (Fig. 1).

The particular hydrographic regions influence in different ways the development of water circulation in the whole of the investigated river basin, i.e. also its water balance and stream regime. The retention conditions (considerable infiltration) favour the formation of rich reservoirs of underground waters. The Karst rocks in this region are particularly important in the collection of underground waters, and have a favourable effect on the water stages and discharges of the Tatra streams and the Czarny Dunajec. In the Tatra part of the Czarny Dunajec basin (occupying an area of 75 km^2) 38% of the water comes from the crystalline-morainic subregion (which occupies 48% of the area), 48% from the calcareous-dolomitic subregion (32% of the area), and 14% from the dolomitic-shaly subregion (20% of the area).

Measurements of discharge made simultaneously on the borders of the particular subregions at different water levels have shown that the calcareous-dolomitic subregion plays the most important role in supplying the Kościeliski Stream (the area of the river basin is about 35 km^2). At low and medium water levels this subregion (occupying 47% of the catchment area) supplies to the stream about 70% water, at high water levels 35 to 45%. The crystalline-morainic subregion (43% of the catchment area) at high water levels supplies to the stream 33 to 46% of its water, and the dolomitic-shaly subregion (11% of the catchment area) 13 to 24% respectively. The immense supply of water from the calcareous-dolomitic subregion at medium and low water levels gives evidence of the considerable retention capacity in the Karst catchment basin. It is also due to the inflow of underground waters from beyond the river basin in a southeastern direction, which was already mentioned above. The small supply of water from the crystalline-morainic subregion at the low and medium water levels, considerably increasing during high water levels, indicates a smaller retention capacity in the crystalline region, and to a higher rate of run-off. The dolomitic-shaly subregion at low and medium water levels has no share in supplying the Kościeliski Stream, whereas at high water levels it greatly increases the discharge.

In the catchment basin of the Chochołowski Stream which covers an area of about 35 km² the main water supply at low, medium and high water levels comes from the crystalline-morainic subregion occupying 58% of the catchment basin area. It provides 48 to 60% of the water. The supply from the calcareous-dolomitic subregion (22% of the catchment basin area) is 15 to 25%, from the dolomitic-shaly subregion (20% of the catchment basin area) analogically 15 to 25%.

The Kościeliski Stream, chiefly supplied by underground waters from the calcareous-dolomitic subregion, shows in comparison with the Chochołowski Stream very small fluctuations in the water levels. The predominance of the supply from the crystalline-morainic subregion with associated run-off and infiltration is the cause of the greater fluctuations of the Chochołowski Stream.

Investigations and a detailed analysis the hydrographic data have proved that both the water circulation and the water balance of the Western Tatra Mts. are very complicated, showing a considerable differentiation according to the geographical environment, particularly as regards geological structure and relief. Where the geological structure is favourable to infiltration, the mountainous region has a high retention capacity and rate of subsurface run-off together with a considerable surface run-off. These different conditions in run-off and retention capacity which prevail in the particular regions of differing geological structure and relief, have led to the development of different types of water circulation in the particular parts of the river basin.

In the high-mountain crystalline-morainic river basin of glacial relief there prevails a run-off infiltration regime. Large cirques and glacial valleys lined with permeable morainic materials lying on the impermeable crystalline substratum favour the shallow infiltration of waters.

In the high-mountain calcareous-dolomitic river basin of fluvial or glacial relief showing well developed karstic features an infiltration regime prevails. The fissured Karst substratum, in spite of unfavourable orographic conditions, provides propitious conditions for infiltration and makes possible the deep circulation of water.

In the middle-high mountain calcareous-shaly or dolomitic-shaly river basin there prevails a run-off — infiltration or infiltration — run-off regime, according to the degree of retention capacity of the substratum.

The arrangement of the river basin, and the situation of run-off areas above the infiltration ones has a favourable effect on the development of water circulation in the Western Tatra Mts., causing the retardation of run-off and retention in the river basin. The configuration, geological structure, and vegetation cover influence the spacial differentiation of water phenomena in this region, whereas climatic conditions cause their differentiation in time. Similarly diversified water conditions probably exist in other mountainous regions of differing elements of the geographical environment, especially in areas of varying geological structure.

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THE PROBLEM OF TAXONOMY OF NATURAL UNITS IN REGIONAL GEOGRAPHY

JERZY KONDRACKI

Regional geography is defined sometimes after Vidal de la Blache as the "study of places" However, this simple definition is not enough because the sum of all the changing phenomena relative to some particular terrain, very often can not be logically connected and in particular, natural phenomena on one hand and man and his activity on the other, are two different circles of the problem. The integration of the various components in both these two categories of phenomena not only requires other methods but also has entirely different objectives. That is why we find in the regional geographical publication three different points of view: the physico-geographical, the socio-geographical and the eclectic one. In the first instance, the object for study is the territory more or less homogeneous in character as regards natural conditions and is distinguished on one feature or its whole complex. A number of geographers are of the opinion that the pure natural point of view is not proper to our science, in which the meaningful subject is an analysis of the connection that arises between human societies and their natural environment. This is of course socio-economic point of view which can not pretend to be exclusive. The economic geographer analyses the connections that exist between man and his geographical environment in relation to the various conceptions of the spatial units — historical, and political units (mainly states and administrative units) — ethnographical units and lastly economical units.

The monographs of different larger or smaller freely defined territories represent mostly the eclectic, descriptive point od view. There, the natural characteristics form a seperate part of the work which is not connected to characteristics of population and economy. Besides this, such books published are often written by two authors, each on different directions of interest.

So it can be seen that each of these three points of view have their reason for existing and because of this, regional geography does not constitute a seperate branch of study but is an integral part not only of, physical but also of economic geography in the widest meaning of the term. The mechanical connection of these two directions, in the various descriptions and regional monographs, does not open a new branch of study but is useful mean of information. All discussion on the subject of "unitary geography" has had until now a scholastic character. Consequently, bearing the eternal duplicity of geography in mind, it would seem necessary to employ methodology of regionalization in the two fundamental directions of investigation.

The International Geographical Union formed a Commission on Methods of Economic Regionalization, an action which aroused a very wide interest. But the problem of physico-geographical regionalization did not appear on the actual programme of international discussion of the effort to co-ordinate. It has had however, a long history. We have not enough space to describe the development of opinions in full. In order to sum it up in the shortest way, it is necessary to first state that specialization in various directions of investigations in the frame of geographical study has led to the formation of varied regional divisions evolved from the varying points of view. American and Swiss geographers among others adhere to the opinion that every division of the Earth's surface (geosphere) is subjective in character and is only a tool in the hands of the examiner, simplifying the description and analysis of phenomena.

Soviet geographers are of another opinion and consider that the differentiation of the Earth's surface — the geographical cover or the landscape cover — is objective. Their starting point is the opinion that geographical environment institutes a complex mutual connection of phenomena among which are the opposing processes arising from the flow of external energy — mainly from the sun — and the processes arising from the interior of the Earth. To simplify this we can say that the actual differentiation of theEarth's surface is on one hand the sum of all the alternating tectonic changes, expressed by continental platforms, oceanic basins, mountains and oceanic troughs and on the other hand by the sum of all the physical phenomena that have roots in climatic processes — distribution, and regimes of water, geomorphic processes, vegetation and in consequence soils and animal world. The tectonic differentation of the Earth's surface exists objectively, is subject to comparative slow variation, is marked mathematically on maps and has been for a long time the basis of geographical division of the Earth. In this same way, the changes caused by the climate exist objectively, although the designation of boundaries of this differentiation is never easy because of the great variability of climatic phenomena in time and space. However, more or less enduring evidence is presented by the landforms, the vegetational cover,and soils. Because of this, natural regional differences are not subjective but really exist and the physico-geographical regionalization of the Earth is possible by the imposition of the two systems of divison — endogenous and exogenic.

Work on physico-geographical regionalization is advanced in the Soviet Union, Poland, in both the German States and in many other countries, although they do not always support a comparative system of taxonomy. For this reason, it is necessary to discuss and determine a system of physico-geographical units analogically, as was done considerably earlier in the field of biological study — the system of the animal and vegetable world — and geological study — the division of the history of the Earth.

We can determine the natural units in two ways — "from above" — that is to say from the biggest unit to the smallest and — "from below" — starting from the smallest territorial complexes. In this sphere there also exists a certain divergence of opinion because a group of Soviet authors consider "landscape" as the smallest regional unit and this should be composed of a certain number of smaller units which are typological not regional. This point of view however, may seem a little scholastic because even some of the smaller units such as peat bog, sand dune or morainic hill are not only types but also individualities. Also the landscape can be classified as a typological unit of the higher rank. There is another group of Soviet authors, among them Armand, Milkov, Raman, Efremov, Gvozdetski and also a group of German authors: Gellert, Schulze, Paffen, Schmithüsen and many others who hold the opinion that basic physico-geographical unit is that part of the Earth's surface which is of a homogeneous geological structure, relief, soil, water conditions, vegetation and microclimate. Such a unit is called *biogeocenose*, *facies*, *Landschaftszelle*, *Fliese*, *physiotop*, *oecotop*, site etc. The distinguishing of such a unit is possible on the basis of a detailed phytosociological and pedological survey on the scale of 1:1,000 to 1:10,000 and is of great practical use.

TABLE 1. COMPARISON OF TAXONOMIC REGIONALIZATION SYSTEMS

Soviet System (Gvozdetski 1960)	German System (Schmithüsen, Meynen 1953)	(Paffen 1953)	Polish System (Kondracki 1961)
land (*strana*)	—		area (*obszar*)
zone (*zona*)	—		zone (*strefa*)
province or *area* (*provincia*, *oblast*)	*Gruppe von Grosslandschaften*		province (*prowincja*)
subzone (*podzona*)	—		subprovince (*podprowincja*)
district (*okrug*)	*Grosslandschaft*	*Macrochor*	macroregion (*makroregion*)
subdistrict (*podokrug*)	—	*Mezochor*	mezoregion (*mezoregion*)
region (*rayon*) or landscape (*landshaft*)	*Landschaft*	*Microchor*	microregion (*mikroregion*)

The higher rank units are the group of *facies* which form a genetic entity in its whole: peat bog, gorge etc,. This is called in the Russian language *urotshishtshe* and in German *Fliesenkomplex*, *Landschaftszellenkomplex* etc. Then the groups of these genetic homogeneous units form the regional units known in literature as "natural region", *Landschaft*, "landscape" etc.

These three or more steps in the scale of differentiations can be observed and directly surveyed on topographic maps of various scales.

The units of the highest rank can be distinguished on a small scale, taking the basic maps of single components and bearing in mind, on one hand the relief and structure of the Earth's surface, on the other hand, the relations of the climate, soil and vegetation. That integral point of view, by the diversity of the Earth's surface, establishes an occasion for subjectivism on the construction of a system of division but therefore it would seem possible to establish the principles and criterions.

TABLE 2.

AN EXAMPLE OF DIVISION INTO THE SUB-PROVINCES

Province	Sub-Province
19. Central European Plain	Jutland Peninsula Danish Islands Rhine Lowland Lithoral of Southern Baltic Southern Baltic Lakelands German Plain Polish Plain
20. Middle-German Mountains	Rheinische Schiefergebirge Central Rhine-Land Schwäbisch-Fränkischer Becken Thüringer Becken
2. Bohemian Massif	Sudety Mountains Erzgebirge (Krušné Hory) Northern Cretaceous Plateau Berounka Plateau Czecho-Moravian Plateau (Ceskomoravska Vysočina)
22. Lesser Poland Plateau	Silesian and Cracovian Plateau Central Polish Plateaus
23. French Plateaus and Basins	Massif Armoricain Massif Central Aquitanian Basin Parisian Basin

On account of the vastness of its territory the Soviet geographers have the most experience in the determination of the large natural units. We can touch here on the system of regionalization of the European part of the U.S.S.R. presented on the Third Congress of the Geographical Society of the U.S.S.R. in Kiev 1960, comparing it to the system accepted by the *Bundesanstalt fur Landeskunde* and also to the Polish system of physico-geographical regionalization, published by the author in 1961 (Table 1).

In this table of comparisons the units smaller than landscapes and also the continents are omitted.

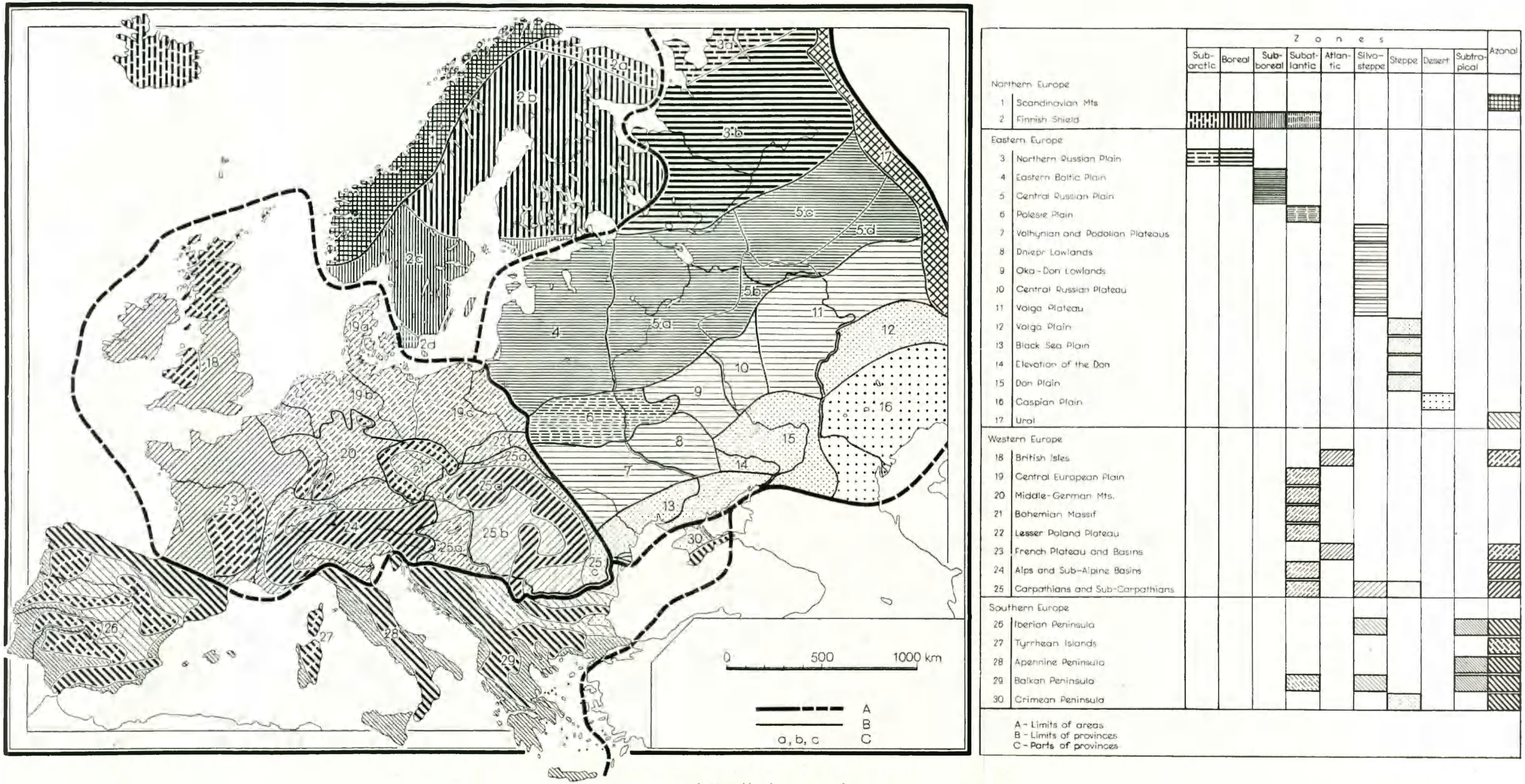

Fig 1. Natural geographical units of Europe

periglacial subprovince. They differ not only in their relief but also in their water conditions and consequently their soils. The littoral of the North Sea, of the Baltic Sea, of the Danish Islands and of the Jutland Peninsula are also distinctive in character. The subprovinces of the Bohemian Massif are: the Sudety Mts., the Erzgebirge Mountains, the Southern Bohemian Plateau, Northern Cretaceous Plateau, Berounka Plateau, and the Czecho-Moravian Plateau.

Through Polish territory runs a boundary dividing Eastern and Western Europe and which reveals a deep structural fracture of the pre-Cambrian Continental Platform lying in the bedrock of younger sediments. This boundary runs on the Eastern side of the Vistula from north-west to south-east, but it is not visible in the morphology of the Earth's surface. Even so, its geographical significance is underlined by the differences of the climate and the vegetation in the West and in the East. The former has a suboceanic climate varying in general not so much in the meridional direction as from East to West, whereas above all in Eastern Europe at that same time, the meridional variations are remarkably apparent, finding significance in the characteristic zonalization. The sub-boreal zone and silvo-steppe of Eastern Europe end themselves on the Polish territory, while on the other hand, the zone of mixed forests is evident in both these two areas. The Western boundary of these two mentioned zones is therefore the boundary between Eastern Europe and Western Europe.

These are only general lines, which are used as a means of demonstration, making it evident that is is possible to standardize and systemize the physico-geographical units of the higher order, independent of historical traditions and of political boundaries — and with regard to this geographers can not always free themselves from certain prejudices. Furthermore an agreement on the system of the division of the natural unit is not aided by the direct exchange of thought on the international forum because topical publications printed in the various countries are not of a similar approach and work with a differing terminology. It is evident, this is not a satisfactory way to approach the opinions.

Physical regional geography as a science of the complex natural differentiation of the Earth's surface should be founded on an improved taxonomic system and improved terminology and therefore it would be possible to demand the calling of a suitable international commisssion or at least to organize a symposium on this subject.

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LES MIGRATIONS PASTORALES ET L'AMÉNAGEMENT DES ALPAGES DANS LES CARPATHES POLONAISES

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L'aménagement des alpages et l'établissement saisonnier des pâtres qui l'accompagne, sont des éléments stables du développement de maintes zones montagneuses en Europe. Au fur et à mesure du progrès des forces productives, les formes de l'aménagement des alpages changent ainsi que sa participation dans l'ensemble de l'économie de ces régions.

Les Carpathes polonaises sont en général des montagnes moyennes, car le paysage et les altitudes typiquement alpins n'apparaissent que dans la petite zone, c'est-à-dire dans les Tatras. La principale région des Carpathes polonaises, appelée Beskides Occidentales et Bieszczady, est une formation jeune. Les arêtes et les cîmes sont en général presque dépourvues de pentes abruptes et d'escarpements. Elles sont pourtant le résultat de la composition pétrographique de ces montagnes plissées, composées pour la plupart de flych relativement peu résistant à l'érosion. Des forêts mélangées s'y déploient actuellement composées pour la plupart de sapins blancs, même dans la zone inférieure de végétation. Outre les Pré-Carpathes, les vallées des Beskides s'élèvent à une altitude de 400-450 m., tandis que les arêtes culminent vers 550—1.300 m et que le sommet de la Babia Góra atteint 1.725 m. Dans les Tatras polonaises quelques cîmes dépassent 2.000 m avec un maximum de 2.499 m (Rysy).

La zone naturelle des alpages, des prés de montagne, apparaît dans les parties les plus élevées des Beskides, au-dessus de 1400, et dans les Tatras au-dessus de 1500 m. C'est le résultat des conditions climatiques et de la prédominance des forêts qui en découle. Cependant le défrichement des forêts provoqua non seulement un abaissement artificiel de la limite supérieure des forêts, mais aussi leur destruction dans la zone des forêts, sur des espaces qui devinrent prairies et pâturages et sur lesquels depuis de longues années on effectue une exploitation pastorale du type estival [2]. Voilà l'unique facon qui permet d'exploiter ces alpages artificiels et partiellement naturels, car d'une part leur accès et leur exploitation en hiver sont difficiles et d'autre part ils sont à ce point éloignés des villages qu'il est impossible d'y ramener les troupeaux pour la nuit. Il en résulte la nécessité des migrations pastorales saisonnières.

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La vie pastorale dans les Carpathes polonaises était traditionnellement semblable à celle des Balkans et des Carpathes du Sud où cette forme d'élevage, fortement développée, existait depuis longtemps. Elle était liée aux migrations des populations valaques avec leurs troupeaux à travers les Carpathes orientales jusqu'à la partie polonaise de ces montagnes. Au XIIIe et XIVe siècle, l'agriculture étant encore inconnue dans les Carpathes, les migrations des populations (ou selon d'autres auteurs uniquement les migrations de civilisation) étaient faciles. C'est pourquoi les pâtres ne rencontraient pas d'obstacles dans leurs migrations qui avaient alors, plus ou moins, la forme d'un nomadisme typique.

Les formes primitives des migrations pastorales changèrent pourtant au fur et à mesure de la poussée de la population agricole sur les terrains des Carpathes, ainsi que sous l'influence d'un climat plus rigoureux. Au cours du XVIe siècle la transhumance gagna de l'importance et se maintint jusqu'au XVIIIe siècle. Puis, à la suite de la diminution des superficies des pâturages d'hiver en faveur des champs cultivés, et du déplacement des villages des Carpathes occidentales vers les pâturages d'été, ce type évolua à nouveau, se transforma en un pâturage estival (estivage) de montagne. Celui-ci est aussi appelé par d'autres auteurs "vie pastorale" (*szałaśnictwo*) [14]. Par contre le type helvétique [7], caractérisé par un village saisonnier ("montagnette"), habité en été par toute la population, ne s'est pas développé à cause de la faible altitude des alpages et du pâturage d'été dans les montagnes. En principe ce pâturage ne s'effectue que dans une seule zone d'altitude, sauf dans les Tatras où deux zones se sont formées.

Dans les Carpathes, en raison d'une économie autrefois peu développée et des efforts des montagnards pour atteindre le plus haut degré d'autarchie familiale, l'élevage caractérisé par un pâturage sur les alpages ne s'est pas développé conformément aux possibilités naturelles du milieu. L'unique exception est la zone des Tatras, y compris sa partie slovaque, ainsi que la région polonaise du Podhale, où a pris naissance un centre important d'ovins qui n'a son équivalent qu'en Roumanie, dans les Marginea.

C'est pourquoi dans la période entre les deux guerres sur la vaste partie des Beskides appartenant à la Pologne, on faisait paître sur les alpages environ 24.500 ovins et 3.900 bovins par an. Dans les Tatras polonaises il n'y avait qu'environ 11.000 ovins et 3.000 bovins[1], et, simultanément, en certaines

[1] Surtout d'apres le travail de Z. Holub-Pacewicz [9].

années, les ovins se déplaçaient du Podhale en Slovaquie. En ce qui concerne toutes les Carpathes, y compris leur partie polonaise, le pâturage des ovins était, et reste toujours, caractéristique, bien qu'en Pologne et dans ses régions montagneuses l'effectif des bovins dépasse celui des ovins. Entre les deux guerres, la vie pastorale sur les alpages était du type traditionnel propre aux petites exploitations, dont la production globale était insignifiante.

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Un développement intense de l'élevage des ovins au détriment de celui des bovins, peu favorable à l'économie des Carpathes polonaises, a été observé dans la période de la seconde guerre mondiale, surtout dans les Tatras et au Podhale. En 1947, dans les seules Tatras polonaises, on faisait paître plus de 20.000 ovins et plus d'un millier de bovins [10]. Cet état de choses était très défavorable et néfaste à la protection de la nature dans les Tatras. On estime que dans tout le *powiat* de Nowy Targ (Podhale) il y avait un excédent de 40.000 ovins adultes.

Pour améliorer cette situation on envisagea le transfert des ovins dans d'autres régions. Les parties des Carpathes polonaises situeés plus à l'Est furent choisies, c'est-à-dire dans la région du village Jaworki (partie orientale du *powiat* de Nowy Targ) ainsi que dans quelques districts de montagne de la voïvodie de Rzeszow et particulièrement dans les Bieszczady. Ceci fut rendu possible par la diminution de la population due à la transplantation des groupes ethniques non-polonais.

En 1948 7.800 ovins avaient été déjà déplacés dans la région de Jaworki, éloignée de 50 km; ainsi sur les alpages des Tatras ne restèrent que 13.500 bêtes [11]. Ce centre de pâturage existe encore actuellement. Il profite de la présence d'une station expérimentale de prés, d'un centre vétérinaire, d'une station d'insémination ainsi que d'une laiterie. En 1950 s'effectua une nouvelle transplantation de 4.500 ovins des villages subtatriques vers les Beskides de Sącz (60—80 km) et d'environ 10.000 ovins vers les districts voisins de la voïvodie de Rzeszów, surtout par voie ferrée. Sur les terrains des Beskides de Sącz s'est également développé, au cours des annés, le pâturage des ovins provenant des villages voisins. L'aménagement des alpages fut protégé par les autorités du district et par un comité spécial. Dans les années 1959—1961 on y faisait paître environ 6.000 ovins et 500 bovins [4].

Depuis 1953 le centre de migration des ovins du Podhale s'est déplacé vers les parties orientales de la voïvodie de Rzeszów (*powiats* de Sanok, Lesko et d'Ustrzyki [13]), à une distance de 300 km. Dans les années 1953—1956 on a envoyé dans cette zone 20.000 ovins par an et on le contituait les années suivantes. Dans l'ensemble, la vie pastorale engloba au cours des années suivantes plus de 30.000 ovins et seulement 3.400 bovins. Le pâturage s'y

Fig. 1. A. Les directions des migrations pastorales des ovins de Podhale et Tatras vers les autres parties des Carpathes Polonaises. B. Répartition des régions d'alpages dans les Carpathes Polonaises.

1 — directions depuis 1948, 2 — directions depuis 1952, 3 — les traces de la semitranshumance (Fig. B uniquement), 4 — régions d'alpages, 5 — frontière politique (Fig. A uniquement), 6 — frontières de voïvodie, 7 — frontières de districts, 8 — chef-lieux de districts, 9 — noms de régions d' alpages (Fig. A uniquement), 10 — fleuves et rivières

effectue dans des conditions primitives et provisoires. Néanmoins la production de lait et de produits laitiers est relativement considérable.

De cette façon l'exploitation des alpages tatriques est devenue moins intensive. Effectivement, en 1961 le nombre d'ovins était inférieur à 5.000 et celui des bovins à 800 [15]. Dans l'ensemble de l'élevage dans les Carpathes polonaises, les Tatras ne représentent plus que moins de 10% en ce qui concerne les ovins, et moins de 25% en ce qui concerne les bovins. Cependant le nombre d'ovins appartenant aux montagnards du Podhale (*powiat* de Nowy Targ) est encore supérieur au tiers de l'effectif global des ovins dans les alpages des Carpathes polonaises. Ainsi l'aménagement des alpages est toujours mené par les montagnards de ce grand centre d'élevage des ovins qui se trouve dans le *powiat* de Nowy Targ.

Le Beskide de Silésie, aux confins occidentaux des Carpathes polonaises, est la seule région importante dont l'élevage des ovins ne soit pas lié à celui du Podhale. Il est très intéressant de constater que, jusqu'à nos jours il persiste un double mouvement de migration des troupeaux vers les plaines voisines, l'un en automne et l'autre au printemps (semitranshumance).

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On estime que dans les Carpathes polonaises la superficie des alpages représente plus de 500 km², soit 16% de la surface des prés et pâturages, et 3% de la superficie totale. Sur cette surface-là paissent 60.000—70.000 ovins soit environ 32% de l'effectif total des ovins des Carpathes polonaises. En admettant 4 ovins par hectare et en réservant un certain pourcentage de l'étendue des alpages pour les prairies destinées au fauchage, 160.000—180.000 ovins pourraient pâturer dans l'état actuel de l'exploitation. Ceci donne une idée du caractère extensif de cette exploitation. Celle-ci pourrait être plus productive. Environ 50.000 bovins, c'est à dire 10% de la totalité de l'élevage de bovins dans les Carpathes polonaises, y trouveraient une nourriture suffisante.

Le pâturage des bovins est plus avantageux que celui des ovins, tel que le montre l'enquête réalisée en 1961 dans le Beskide de Sącz [5]. L'expérience prouve que l'élevage des bovins destinés à la consommation de la viande, par rapport à celui des ovins, augmente le revenu de l'exploitation des alpages de 20%. Si l'élevage était destiné à moitié à la production du lait, le revenu brut pourrait augmenter de 100% et le revenu net de 80% (dans ce cas les frais généraux sont plus élevés). Il semble que cette estimation puisse se rapporter à bien d'autres parties des Carpathes, où jusqu'à présent l'élevage des ovins est considérablement supérieur à celui des bovins.

L'aménagement des alpages dans les Carpathes c'est surtout l'oeuvre des fermiers particuliers, car les formes de l'économie nationalisée y sont moins développées que dans d'autres parties de la Pologne. Ceci concerne presque entièrement l'élevage des ovins. Sur les terrains traditionnels, c'est à dire dans les Tatras, le Beskide de Silésie, au Haut-Beskide et à Gorce, il existe jusqu'à nos jours, d'anciennes sociétés privées de pâtres dont les statuts sont basés sur la tradition. Leurs investissements et productivité sont insignifiants. Par contre les centres de l'élevages des ovins organisés après la guerre, pour la plupart sur de nouveaux terrains appartenant à l'Etat et aux *PGR* (fermes d'état), ainsi qu'à la Direction du Parc National des Tatras, dans les Bieszczady, sont également des entreprises privées de bergers-chefs (chef de pâturages, *baca*) quoique sous la protection et le contrôle des autorités locales. Le *baca* prend à ferme non seulement les pâturages, mais aussi les owins des montagnards des Beskides ou de ceux du Podhale qui sont pour la plupart des petits fermiers. Sur la base de ce double fermage les *bacas* exploitent les alpages à leur propre compte. Ils vendent les produits laitiers, surtout le *bundz* (fromage cru de brebis), et parfois même, par exemple dans les Bieszczady, uniquement le lait de brebis aux laiteries locales d'état ou aux coopératives.

Par contre le pâturage des bovins sur les alpages, d'une envergure bien inférieure à celui des ovins, commence à être organisé par l'Etat et par les coopératives; abstraction faite d'un petit nombre de bovins entretenus par les *bacas* pour leurs propres besoins. Les alpages destinés au pâturage exclusif des bovins sont organisés en premier lieu par les *PGR*. Il y a aussi quelques grandes entreprises industrielles qui ont sur les alpages administrés par elles-mêmes du bétail destiné à la consommation de leurs travailleurs (par exemple Nowa Huta, près de Cracovie, a son alpage dans le *powiat* de Nowy Sącz). Il y a également quelques coopératives paysannes de production qui font paître sur les alpages leurs propres troupeaux. Ceci est pratiqué ça et là par les *Kółka Rolnicze* (coopératives d'agriculteurs pour le commerce et le ravitaillement), les entreprises d'élevage du bétail de race et également par les postes vétérinaires.

Pour la plupart ce sont les jeunes membres des familles de petits fermiers ou de celles n'ayant pas de terre qui travaillent sur les alpages. En général environ 1500 travailleurs y sont occupés, ce qui est un nombre relativement insignifiant par rapport à celui de la population exerçant un métier dans les Carpathes. Ces travailleurs de saison d'été sont bien payés, car outre leur rémunération en argent ils reçoivent des vêtements de travail, de la nourriture, des cigarettes etc. Pour le moment la conjoncture sur le marché du travail dans les Carpathes permet d'engager un personnel convenable. Ce n'est que dans la région plus industrialisée du Beskide de Silésie que l'on observe des manques assez considérables de la main-d'oeuvre.

Les *bacas* proviennent pour la plupart des familles de montagnards de la région des Tatra exerçant traditionnellement ce métier. Dans le cas de troupeaux de 500 ovins, ce qui est un nombre moyen, la production rapporte environ 130.000 *zloty*. Le revenu net des *bacas* est estimé à environ 25% de cette somme. Ils travaillent durant cinq mois par an, souvent dans des conditions bien primitives; les prix de revient sont relativement bas, mais leurs revenus sont relativement grands. Ils les dépensent d'habitude pour satisfaire leurs besoins personnels (vêtements, meubles, radio, parfois motocyclette ou téléviseur). Une faible partie du revenu est investie pour faire hausser la production dans leurs fermes à un moinder degré dans les alpages.

Les migrations saisonnières des habitants du Podhale vers les pâturages des Bieszczady, et l'action ayant pour but la colonisation de cette partie orientale des Carpates polonaises, devaient diminuer les symptômes du surpeuplement dans le *powiat* de Nowy Targ. Pourtant jusqu'à présent cette action n'a pas donné de résultats satisfaisants.

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Ainsi dans cette exploitation des alpages, encore assez primitive du point de vue économique, et basée sur le pâturage des ovins, le signe d'un début du progrès consiste en un progressif, bien que lent développement du pâturage des bovins. Ce pâturage a pour but, en parties égales, la production du lait et l'élevage pour la consommation dans le cadre du secteur nationalisé. Pour le moment les fermes d'état sont les plus nombreuses, mais dans l'avenir il faudrait qu'il y ait plus de coopératives de production s'occupant de l'élevage et du pâturage. L'aménagement des alpages et les migrations pastorales devraient mener alors à une exploitation plus intensive, des alpages. Ils deviendraient peut-être un des nombreux éléments de l'agriculture carpatienne, mais en jouant un plus grand rôle dans la production.

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MIGRATIONS OF POPULATION IN EAST-CENTRAL EUROPE FROM 1939—1955

LESZEK KOSINSKI

This is a further attempt to sum up the migrations in the area of East-Central Europe. It is based on the available bibliography as well as the author's own research. The statistical results of all previous studies differ one from another, as a result not only of the different approach of students, but also because of the difficulties of obtaining precise basic data. Because of the lack of official sources it is necessary to consider estimates of various elements of the migratory movements. Some estimates vary considerably. In the future when further data become available, it may be possible to define more precisely the volume and directions of the movements. However, even further data should not change the present picture too drastically.

The migration which occurred between 1939-1945 in this part of the world exceeds both in volume and intensity all other contemporary movements of population. The results of present studies indicate, that at least 24.6 million people were involved, whereas the largest Asian migration, between India and Pakistan concerned only 18 million.

The present discussion is limited to the area of 6 countries: Poland, Czechoslovakia, Hungary, Rumania, Bulgaria and Yugoslavia. Some of the migrations occurring on the peripheries of this area were also taken into account.

One should look for the genesis of the movements involved within the very complex patterns of ethnic structure of the area under discussion. Such a structure was the result of the superimposition of different settlement waves, very often interconnected with the political expansion of neighbouring powers. In this situation therefore it was impossible to realize the concept of national states which was so popular just after the First World War. As a result, almost all the states in East-Central Europe had numerous minorities within their frontiers. The proportion of minorities was especially high in Czechoslovakia (34%), Poland (31%) and Rumania (28%). In all six countries the number of minorities reached a total of 24 million as compared with a total population of 91.5 million. The victorious powers acknowledged the right of minorities to maintain not only their cultural but also political identity. Consequently, special Minority treaties safeguarding these rights were imposed by the allies on the smaller states especially in Eastern and Southeastern Europe. The minority system of the League of Nations did not however adequately protect the minorities against the suppression of theruling nations. On the other hand. many minority groups, disloyal to their states led subversive movements. It is characteristic that in Czechoslovakia — the most liberal state — the minorities contributed a great deal to the fall of statehood.

The general failure of the then existing system, as well as an additional complication caused by the treacherous behaviour of some of the minority groups during the Second World War, called for a different and resolute solution. Since the friendly coexistence of the various ethnic groups was unlikely — the only possible solution was either appropriate border adjustment — which would not eliminate the problem completely, or the transfer of population. The political rather than ethnic criteria were given priority, the latter was accepted as a solution. This decision was based on successful experiences of population transfers in the Balkan countries both during and after the First World War[1].

It should be emphasized that when the decisions of victorious powers were made, the great migrations in East-Central Europe were already under way. They started in 1939 when Hitler's *régime* began to repatriate small dispersed groups of people of German origin (*Volksdeutsche*). Most of these were transferred to the newly conquered areas where they replaced the indigenous Polish population of Western Poland incorporated into the Reich. A large proportion of the Poles was transferred to the reservation of the *General Gouvernement* and all the Jews to the extermination camps. New settlers from the Reich especially administrators and police etc., were also directed to the conquered areas. Other population movements occurred within the *General Gouvernement*, where German colonization schemes were undertaken under the auspices of the *SS*. A forced exodus of population took place also from the Czech and Yugoslav areas incorporated into Germany.

Similar projects were undertaken by Germany's allies, although the numerical scale of the movements was smaller. The Italians deported Yugoslavs from the areas incorporated into Italy, the Hungarians did the same with the Serbs in the Yugoslav provinces of Backa and Baranya incorporated into Hungary, replacing them by Hungarians repatriated from Rumania and Ser-

[1] In that period the total number of refugees and transferees reached about 2,150,000 including more than 200,000 Bulgarians, 450,000 Turks and 1,500,000 Greeks. These migrations contributed to a great extent to the diminution of tensions between the respective countries and despite the personal tragedies of many people involved, eventually served as a good example of how to solve this difficult problem in the interests of peace.

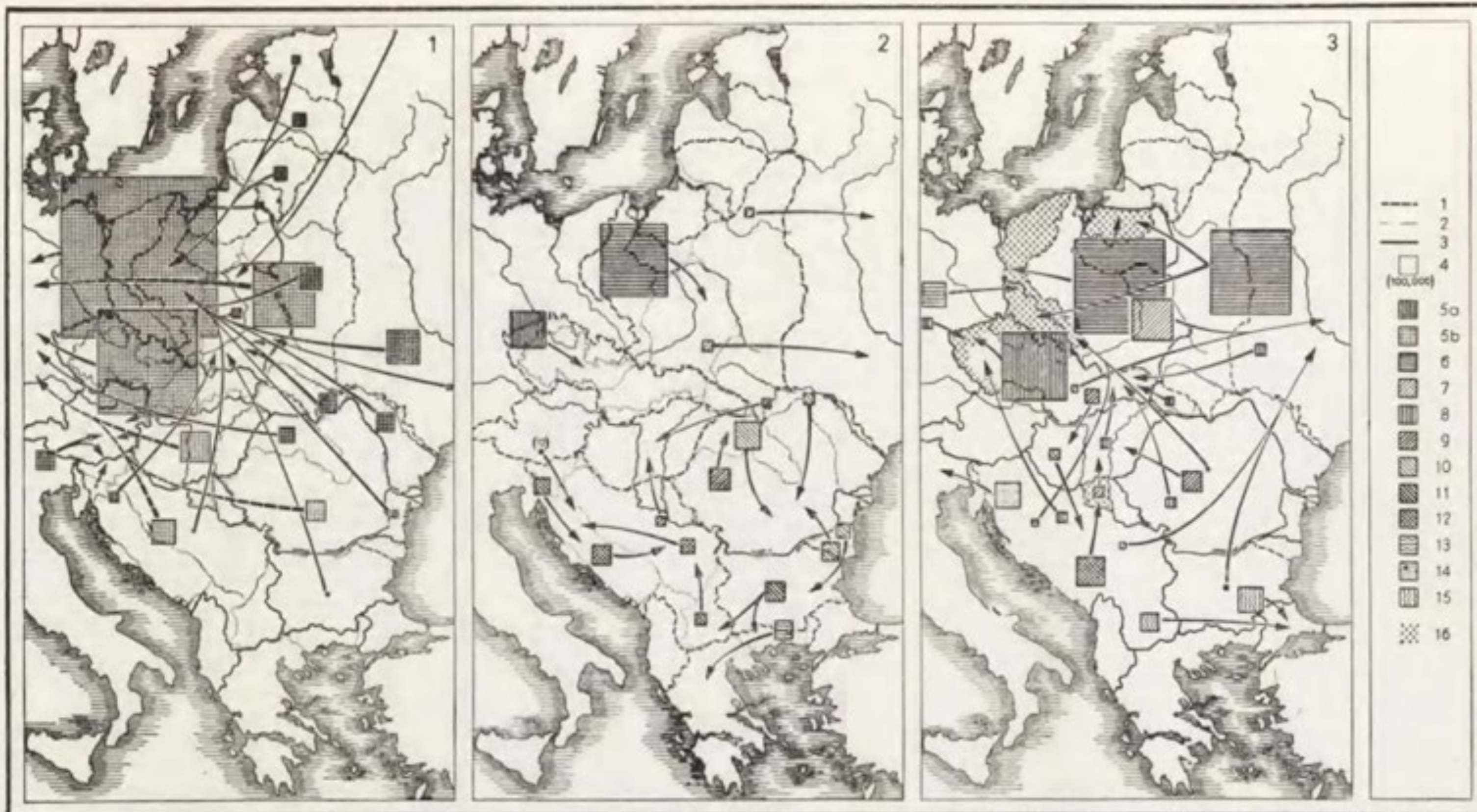

Fig. 1—3. Migrations of population in East-Central Europe from 1939—1955. (1) Departure of Germans from East-Central Europe during and after the Second World War. (2) Transfers of non-German population during the Second World War. (3) Transfers of non-German population after the Second World War

1 — International boundaries in 1937, 2 — International boundaries in 1941 (occupied territories included into the appropriate countries), 3 — International boundaries in 1955, 4 — Number of people transferred, 5 — Germans, a. repatriation during the war, b. evacuation, flight, deportation at the end and after the war, 6 — Poles, 7 — Russians, Belorussians, Ukrainians, 8 — Czechs, Slovaks, 9 — Hungarians, 10 — Rumanians, 11 — Bulgarians, 12 — Yugoslavs, 13 — Greeks, 14 — Italians, 15 — Turks, 16 — Areas of postwar settlement

TABLE 1. MIGRATIONS IN EAST-CENTRAL EUROPE IN 1939—1955 (IN THOUSANDS)

Ethnic groups	War transfers, 1939–1944	Evacuation and flight at the end of war, postwar transfers, 1945–1955	Total	Remarks
Germans—mainly so called *Volksdeutsche*	Repatriation from Italy, U.S.S.R. (incl. Baltic States and other incorporated areas), *General Gouvernement*, Rumania, Bulgaria, Yugoslavia and Hungary 1050* (incl. about 500 who were settled in the Polish areas incorporated into the Reich) Influx from the interior of Germany into newly-conquered Polish territories (mainly administrators) 800*	Evacuation, flight and transfer from: — lost eastern territories and former Free City of Danzig 7300 — Czechoslovakia 3000 — Poland (within 1939 limits) 1200 — Hungary 260 — Yugoslavia 170 — Rumania 120	13,900	About 500 are counted twice (repatriates from the East, settled temporarily during the war in Poland) Moreover during the war ab. 1200 evacuated from the bombed-out areas of Western Germany were temporarily moved into the E. provinces (lost after the war)
Poles	Flight and deportation from the W. areas incorporated into the German Reich 1000* Transfers within *General Gouvernement* 200*	Repatriation from the U.S.S.R. 2000 Repatriation from other countries 200 Colonization of western areas by the settlers from central areas 2000	5,400	Moreover ab. 2500 forced labourers transported into the Reich, transports of Jews into the ghettos and extermination camps, besides several waves of flight and evacuation when the front line moved across the country
Czechs and Slovaks	Flight and deportation from the areas incorported into the German Reich 400*	Repatriation from the U.S.S.R, Hungary, Rumania and Yugoslavia 150 Repatriation from W. Europe 20 Colonization of Border land vacated by Germans — by Czechs and Slovaks 1260	1,830	Moreover transfer of forced labourers to the Reich
Yugoslavs mainly Serbs and Croats	Deportation from the areas incorporated into the Reich and Italy 90* Transfers within Croatia and Serbia 190* Deportation from Macedonia incorporated into Bulgaria 40*	Repatriation from Hungary 40 Colonization of Voivodina 200	560	Moreover transfer of forced labourers to Germany and deportation of Slovenes from the areas incorporated into Germany

Russians, Ukrainians, Belorussians, Lithuanians	Repatriation from the areas under German control 60*	Repatriation from Poland 520 Repatriation from Czechoslovakia, Yugoslavia, Bulgaria 40	620	Besides repatriation from Rumania
Hungarians	Migration from S. to N. Transylvania 160* Repatriation from Rumania 20 Repatriation from Yugoslavia 30	Influx from Czechoslovakia, Yugoslavia, Rumania 220	430	Moreover possibly further repatriation (ab. 130?) Migration losses in 1956—57 (ab. 150)
Rumanians	Migration from N. to S. Transylvania 220* Repatriation from S. to N. Dobrudja 110 Migration from Bessarabia and Bukovina 40		370	Moreover internal movements — settlement of areas vacated by Germans and Hungarians
Bulgarians	Repatriation from N. to S. Dobrudja 60 Temporary settlement in parts of incorporated Macedonia and W. Thrace 120*		180	Moreover possibly internal movements — replacement of departed Turks
Others	Greeks — deported from areas incorporated into Bulgaria 100* Turks — emigration from Bulgaria (1938—44) 50	Turks — emigration from Bulgaria (1945—55) 160 Armenians — emigration from Greece, Bulgaria, Rumania into Soviet Armenia 30 Jews born in Poland, Rumania, Bulgaria, Czechoslovakia, Hungary — emigration to Israel (1946—57) 380 Italians — from Yugoslavia to Italy 200	920	Moreover exodus of Jews to other countries (e.g. U.S.A.)
Totals	4740	19,470	24,210	

* Impermanent migrations — most of the people involved kept moving, mostly returning to their homes

bia. Bulgaria expelled Serbs from Western Macedonia which had been incorporated into Bulgaria, and Greeks from Eastern Macedonia and Western Thrace, replacing the latter by Bulgarian settlers. The puppet state of Croatia also replaced expelled Serbs with repatriated Croats.

Moreover, there were some exchanges of population, connected with international territorial changes — the partition of Transylvania resulted in the exchange of Rumanians for Hungarians, and the Rumanian cession of Southern Dobrudja to Bulgaria resulted in an exchange of Bulgarians for Rumanians.

All these migrations tended towards the simplification of the ethnic structure of the areas involved. Migrations connected with territorial changes proved to be impermanent, since only one territorial change lasted (the cession of Dobrudja). Consequently a large proportion of migrants returned home after the end of the war (Poles, Czechs, Yugoslavs, some Rumanians and Bulgarians) or continued to move (Germans, Hungarians). One suspects that out of the 4.7 million people involved during this stage of the migratory movement only about 0.5 million stayed in the same place.

The second stage of the great migrations began during the last months of the war. They were largely concentrated in the Northern part of the area under discussion, which was being evacuated by the German population. Evacuation, flight, and the first unplanned deportations involved about 7.2 million Germans from the areas East of the Oder-Neisse line later incorporated into Poland and the Soviet Union, from the pre-war area of Poland as well as from Czechoslovakia. The Potsdam decisions had authorized earlier transfers and outlined the principles of further ones. They anticipated the transfer of 6.5 million Germans including 3.5 million from Poland (including former German territory as well as the former Free City of Danzig), 2.5 million from Czechoslovakia and 0.5 million from Hungary. In fact, only 4.8 million people were transferred and even after the completion of the transfer about 0.4 million remained in these three countries. Thus, the Potsdam decisions were directly responsible for the transfer of 35% of Germans and 20% of all the movements involved in this part of the world.

During the early post-war years further movements of non-German population occurred. They were regulated by bilateral agreements. Territorial cessions resulted in the exchange of population between Poland and Czechoslovakia on one hand and the U.S.S.R. on the other. In the two former countries as well as in Yugoslavia, important internal movements concerning about 3.5 million were connected with the colonization of land vacated by Germans. In addition almost all countries regathered their compatriots, who had emigrated earlier. From the area under discussion departed Jewish survivors, who were leaving mainly for Israel. Turks left Bulgaria (especially in 1950-1951), Armenians were leaving for Soviet Union and Italians departed from Yugoslavia. The total of non-German postwar migrants reaches 6 million.

The grand total of migrations has been estimated at 24.2 million. This figure is far from complete, since it includes neither all the war movements (e.g. deportations of forced labourers, of Jews transported to the annihilation camps) nor all the postwar ones (e.g. some internal movements were excluded).

One of the results is a great simplification of the ethnic structure of the area. The size of ethnic minorities is now about 7 million as compared to the total population of 95 million. The average proportion of ethnic minorities dropped from 26% before the last World War to about 7%. The highest proportion, even though lower than before the war are in Rumania (14.3%),

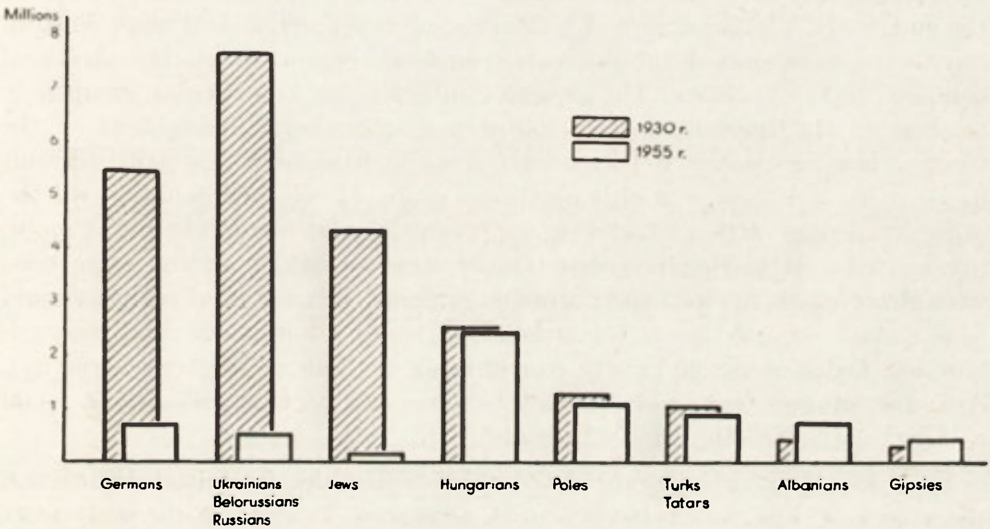

Fig. 4. Major ethnic minorities in East–Central Europe before and after the Second World War

and Yugoslavia (12.2%). There was a dramatic decline of three of the most numerous prewar minorities: of Germans — due to migrations, of Jews — due to extermination and of Ukrainians, Belorussians and Russians — due to territorial shifts and migrations. At the present moment to the three largest minority groups belong Hungarians (in Rumania, Yugoslavia and Czechoslovakia), Turks (in Bulgaria) and Poles. Their number have not changed considerably. However, the location of Polish minority groups has changed. Before the war, they were concentrated in the Eastern parts of Germany, now they are represented by Poles living in neighbouring Soviet republics.

Unlike the pre-Second World War period there no longer exist treaties protecting the political right of minorities. However, protection of individual rights is emphasized. This approach implies the gradual assimilation of minorities. Nevertheless, there exists the opportunity to preserve cultural identity, guaranted by the internal legislation of specific countries.

In scientific literature, particular emphasis is laid on the classification of migrations. The present discussion deals with processes which appear to be easy to define, since they were based on political decisions independent of the population groups involved. Thus it was a forced political migration, although in many cases compulsion was indirect. All the parties concerned considered transfers as a preventive measure, aiming at the elimination of ethnic groups regarded as politically dangerous or at the simplification of the ethnic structure of their territory.

This mass movement, which was without precedent, caused many difficulties both for the countries evacuated and for the countries which received the emigrants. The departure of a total population (e.g. in the Polish Western territories) necessitated the re-creation in that region of all the strata of complex, modern society. The necessity of replacing a particular group (e.g. workers in the specialized light industry in the Czech *Sudetenland* or the German intelligentsia in Baltic countries) might have been especially difficult in view of the shortage of this particular group in any one country. On the other hand, new arrivals had new opportunities and increasing social mobility contributed to the reconstruction of societies, which at the same time were changing their social and economic systems. The influx of refugees could have initially created great transitional difficulties, but it eventually contributed to faster economic growth (the striking example of Western Germany). Arriving refugees were also subject to processes of changes — their social and economic structure had changed.

All students are unanimous in the opinion that despite initial difficulties, the process of integration is very much advanced. In spite of the early fears and prophecies the structure of this part of Europe has not been weakened — on the contrary, it has been greatly strengthened.

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FUNCTIONS AND DYNAMICS OF TRANSITIONAL TYPE SETTLEMENTS IN POLAND

Michał Chilczuk

The main problem of our work was the isolation from other settlements, the settlements of a transitional character. This being our purpose, the investigation suggested not only the towns belonging to the hierarchical network but also a type of rural settlement lower in grade than the local centers of the area, (which are the normal administrative seats of the provincial authorities). The settlements we isolated and we are concerned with those who in regard to their requital functions of service management are complete. These conters are called sub-district centers.

The accepted criteria for the differentiation of the sub-district centers are the actual quality and quantity statuses of the functions, institutions and services of social management with an external scope of activity.

The following is a register of accepted elements of classification covering those factors and is drawn up into 6 groups.

Group I. Establishments of selected branches of the food processing.

1. Bakeries and cake stores.
2. Abbatoires, pork butchers and small slaughtering establishments.
3. Soda drink factories and brewery filling stations.

Group II. Institutions of provision and supply.

1. General and animal markets.
2. Agencies for the purchase of animals for slaughter.
3. Restaurants, inns and food bars.
4. Seats of parish cooperatives of *Samopomoc Chlopska* (Peasants, Mutual Aid).
5. Saving and loan cooperatives.

Group III. Organizations of technical and zootechnical services to agriculture.

1. State machine centers and establishments of agricultural machine repair.
2. Veterinary clinics and consulting points.

Group IV. Services of a socio-cultural character.

1. Schools — secondary and liberal high schools.
2. Trade and general schools.
3. Cinemas — permanent and semipermanent.
4. Health service centers and cooperative poins for doctors, assistant doctors and nurses.

Group V. Facilities and functions of communication.
1. Rail-line stations.
2. Bus-line stops for the *PKS* (State Bus Services).
3. Intensity of the services and measurement of daily frequency of buses and trains.
4. Convenience and the connections with branch lines to other parts of the country.

Group VI. Administrative functions and apprehension of its dynamics.
1. Settlements with rural or urban status.
2. Settlements which had an urban status in the past.
3. Settlements which prior to 1954 were administrative centers.
4. Settlements with seats of the administrative unit of *gromada*.
5. Settlements with police stations.

This selection has illustrated the fundamental factors (institutions, activities and functions) that are met with in Poland on a given grade of the hierarchical network and concerns settlements which in substance exceed the local scope in which they are placed. Undoubtedly it would be possible to take into account still other elements apart from those already mentioned above, such as light industry or trade and the stronger group of shops and their branches etc. but the lack of data on these elements does not permit an analysis on the scale of the country as a whole. Several other elements were omitted, which on closer study do not always prove to be characteristic of the categorical investigation of the settlement, such as schools of 7 grades and parish schools etc.

However, on account of the number of elements on the utility and practicability of isolation, it is possible to investigate the grouping of the settlements.

This work was fundamentally divided into two stages. First, all the studied elements were placed on a map of Poland, scale 1:300,000. Over 7103 settlements were examined in this manner, which is roughly 10% of their number for the whole country. Next, such settlements in which a lower concentration of the investigated elements occured were eliminated from further research. In this way 57% of the investigated settlements were eliminated. The remaining settlements, 2450 in number, were divided into two groups A and B. Into group A 29% of the originally accepted settlements were included when 7 or more of the elements occured. Into group B were included settlements where 4-6 of such elements occured, leaving 14% of the settlements unaccounted for. Group VI elements had not yet been taken into consideration at this stage of the investigation. This decision was prompted by the desire to isolate the central function independently of the not always stable administrative divisions both historical and present. This illustrates the method used in the formation of the map of the sub-district centers (Fig. 1).

After the rejection of those centers with an obvious concentration of the hierarchical administrative functions, the sum of those isolated sub-district centers amounted to the figure of 2050 settlements. Included in this number are 1577 settlements with very clearly defined central functions (type A), as well as 473 centers with a lesser number of elements. From among those determined as sub-district centers, 480 settlements 23,4% are practically towns or urban settlements. From the remaining, 1570 settlements qualified as sub-district centers and 1527 constituted seats of the *gromada* councils. On the other hand, 43 settlements belonging to this category at present do not fulfill any administrative role.

TABLE 1. THE FUNCTIONAL HIERARCHY OF SETTLEMENT UNITS IN POLAND

Grade	Denomination	Number of centers		
		Strongly developed	Weakly developed	Total
I[1]	Village and hamlet	?	?	63 090
II[1]	Hamlet centers	?	?	3 718
III	Sub-district centers	1 577	473	2 050
IV	District centers	297	-	297
V	Sub-regional centers	53	20	73
VI	Regional centers	27	2	29
VII	Capital City	1	—	1

[1] The grades I and II and their relations to the above are problems which have not yet been considered at the present stage of the investigation. Grade II centers were included because the figures for the hamlet centers were less than the required qualitative figures for grade III centers (sub-districts).

Our next task was to select from those already isolated these functional elements which are characteristic to the centers of a sub-district grading. This problem was solved by a cross section of the voivodship, proportioning the total number of the specifications of socio-economical management within the voivodship, with those figures located in the sub-district centers. The following grades were recognized as characteristic of the centers, (commencing with the most characteristic). 1. Saving and loan cooperatives. 2. Agencies for the purchase of animals for slaughter. 3. Cooperative community centers of *Samopomoc Chłopska* (Peasants'Mutual Aid). 4. Collective gastronomic establishments, food bars and inns. 5. Bakeries. 6. Permanent and semipermanent cinemas. 7. Abbatoires, pork butchers and small slaughtering establishments (apart from the eastern voivodships this element is not characteristic). 8. Health centers (apart from the northern voivodships this element is not characteristic). 9. Veterinary clinics and consulting points (apart from the voivodships of Katowice and Opole this element is not characteristic). 10. Local administration as well as the police station.

The investigation also showed that the following are characteristic features of the sub-district centers.

1. Communication junctions, characterized by at least 4 directions of train or bus connections. The study of the frequency of the train or bus on a planned route indicates the service irrespective of the expected passenger count, it does not necessarily determine a sub-district center.

2. The concentration of non-agricultural population is moderate in number, 100 to 300 people. However, in the central voivodships this number varies from 100 to 200 and in the south-western part of the country the difference is much greater, in the neighbourhood of 150 to 450.

The results of the investigation permit the following conclusions:

1. In the Polish settlement network one can establish the regularity of concentration of functions connected with socio-economic servicing of rural areas, in limited number of clearly defined centers.

2. Among such settlements, the sub-district centers represent the highest grade concentrating their functions on the most essential village services.

3. This isolation of the centers does not indicate correlation with the administrative division of the country but with the area they serve, normally confined to the neighbouring hamlets.

During this stage of investigation the problem of the distribution of sub-district centers in relation to their actual catchment areas and number of population serviced had not been taken into account. It was limited to a theoretical recount of the surface as well as of the rural population of the *powiat* devolving on one sub-district center.

The results however sufficiently clearly show on a discriminated surface, these proportions upon the terrain of the country as a whole.

From the included map (Fig. 2) it seems evident that the largest group represents districts in which the average radius of activities and urban population fall into the sub-district examination when they do not exceed 7 km and 7 thousand people (the average over the country being 6.3 km and 6.3 thousand people). Such districts are concentrated in the central and southern part of the country, forming themselves into wide belts along the course of the Vistula. On this area also occur other districts, mainly on the Carpathian highlands and in the Kielce district where the rural population of one sub-district center amounts to more than 7 thousand people. The land to the west and north, Białystok voivodship, the northern part of the Warsaw voivodship, the eastern provinces and Bieszczady Mts. are characterised by a greater radius of services and a greater rural population which falls into one sub-district center. These differences are the unfortunate results of the unequal social development in certain parts of the country.

The investigation showed that characteristic functions of the sub-district centers, as indeed the centers of the other grades, should be treated dynamically because they reflect both the actual production force and its rate as well as the progressive transformations in these directions. Together with the development of the country, its industrialization and reformation of its socio-economic structure, especially its socio-economic situation in the rural area, the sub-district centers are gaining new functions. The functions which were previously characteristic of higher rank centers, typical for the sub-district centers today

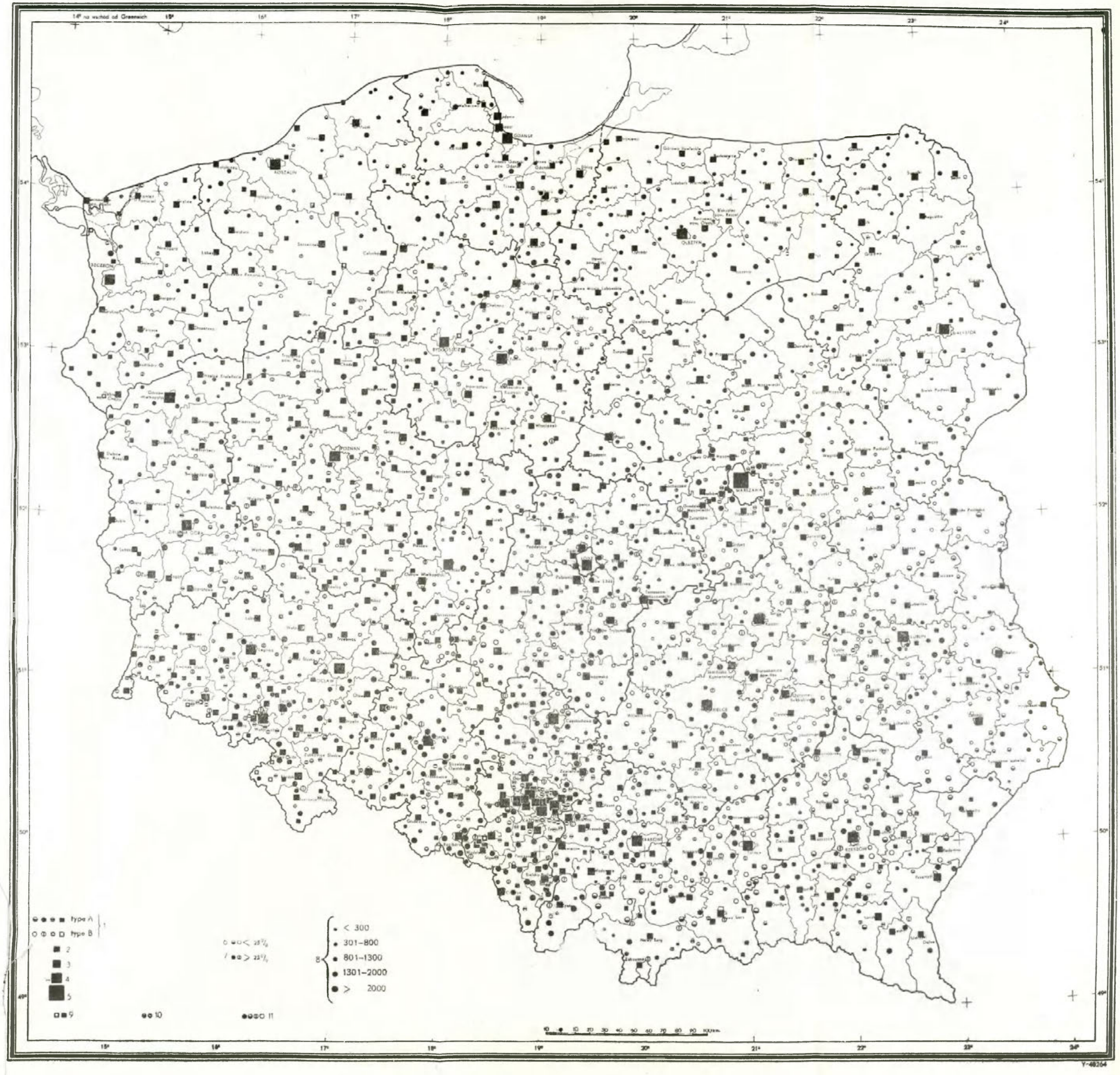

Fig. 1. Functional hierarchy of settlements

Type A — Local centre (centre of a group of villages) with a distinct concentration of certain categories of services and production of non-local character; Type B — Local centre (centre of a group of villages) with insignificant concentration of certain categories of services and production of non-local character, 1 — sub-district centres, 2 — district centres, 3 — sub-regional centres, 4 — regional centres, 5 — capital of the country, 6 — less than 25% of non-agricultural population, 7 — more than 25% of non-agricultural population, 8 — sub-district centres according to the number of inhabitants, 9 — towns and cities, 10 — urban settlements, 11 — villages decided entrance into the village is ensuring a degree of health care that was unknown in the past. Similarly, the educational and cultural amenities are increasing and here the cinema can be mentioned.

The rate of the removal of the differences both in living conditions and socio-economic services between the rural and urban population requires the formation of wider socio-economic methods in the villages as well as completely new functions.

The analysis of the sub-district centers establishes the transitional aspect between villages and towns and proves that they are developing continually and considerably in every country with modern industrial and urban development. It also proves how false and outdated is a district treated as an urban and rural network settlement, when in reality it is a homogeneous network of service centers, mutually interconnected. It does not matter if a network of specialized developments, such as industry, communication and recreation. superimposes itself and disfigures this network. These developments would also require an individual investigation.

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TYPOLOGICAL PROBLEMS IN URBAN GEOGRAPHY

KAZIMIERZ DZIEWOŃSKI

In the development of all sciences which are concerned primarily with the description of some part of reality, there comes a moment when for better understanding and for purposes of comparison, some kind of typology of the described phenomena becomes necessary, and indeed inevitable. Urban geography does not differ in this from other sciences. Even in its initial stages efforts were made to establish one or another systems of dividing towns into different and separate classes, besides studying single, intuitively defined types of urban settlement. Varying criteria — of size of population, of administrative status, of loosely defined functions, such as historical i.e. of age and importance, topographical i.e. of site and situation, and of the character and material, of their buildings, were then used. Perhaps the most complex and certainly the most consistently developed was a typology evolved at the end of the 19th century by O. Schlüter for his study of urban settlements in Eastern Thüringia. Later however with the increasing stress being laid in geography on directly observable phenomena as being the proper object of geographical research, attention was turned towards the physiognomy of the urban landscape and efforts were largely concentrated on classifications based on morphological criteria (e.g. several such systems were used in studies of the historical geography of mediaeval towns, and in the more formal typologies of W. Geisler — 1924, V. Deznai — 1935, and others). These tended however to be rather schematic and the results were neither intelectually very exciting nor did they advance geographical research very far. Then in 1930′ with the introduction of the theory of central places (W. Christaller — 1933, A. Lösch — 1937-1944) attention was turned toward typologies based on an analysis of town functions as expressed in the occupational structure of the town inhabitants and fundamental division into town creating and supplementary, or basic-non basic groups of population and employment (E. Ullman and Ch. Harris — 1943, J. Kostrowicki — 1950, L. Kosiński — 1952-1959, J. Alexandersson — 1956 and others). This last concept was also widely used for planning purposes in the USRR and other socialist countries (Levchenko —

1945, Davidovich — 1947). In spite of often rather sharp criticism both of the theory of central places (e.g. H. Bobek — 1938, E. Neef — 1950, V. V. Pokshishevsky — 1960) and of the functional approach (e.g. H. Blumenfeld — 1955) these last typologies are at present the most developed tools for analysis and classification of towns on a comparative basis. The latest studies introduce certain modifications, mainly by taking into account the time element i.e. the variations in the functional structure due to the comparative age of the given town (whether it is a young, mature or deteriorating urban community within the same socio-economic framework) or, to the stage of socio-economic, regional development (within the whole human society). In this way towns are more and more treated not only as a geographical but also at the same time as a historical phenomena as well, in terms of the whole urban network. Some efforts are also being made in Anglo-Saxon countries to establish a functional typology based on a multi-factor analysis (e.g. C. A. Moser and W. Scott — 1961).

But the morphological typologies were not completely abandoned (e.g. the typology discussed in the interesting handbook on urban geography by G. Schwartz, published in 1959). With the growth of the town- and indeed of physical planning their importance is perhaps again growing. However they are being used now, and further developed, mainly from the point of view of the internal structure and pattern of towns, their complexity, character, and relation to the geographical environment, their origin as well as the trends and possibilities of the present and future urban growth.

Recently it has become more and more obvious that neither of these two basic approaches should be abandoned but that some kind of unified, coordinated typology should be worked out in full detail. In a functional analysis we deal with the content of a town, in the morphological one — with its material form. These two — content and form are closely corelated although quite distinct. They do influence and in turn are influenced — by one another. Together they integrate into the phenomenon we call a "town" or in the United States a "city". The content — functions define the position and relation of the analyzed town to the exterior world; this is why the functional typology leads up to the concept of the urban and, more generally of the settlement network. The material form expresses directly the internal structure of the urban community — the morphological typology is based on the description of the physical pattern of towns. Recently, however, these two: the urban network in some areas and internal physical pattern of many the largest towns has begun to merge together. This is because the largest towns are now phenomena of such size and complexity that the urban area tends to coincide with the regional area. This phenomenon serves to make a unified typology even more necessary.

To base a typology on both the functional and the morphological data a closer definition of their correlation is necessary. Logically the urban functions are primary; they are the formative, town-creating element — while the material form is secondary. But already this statement indicates that there may be a dichotomy in time between the two. And in reality this takes place in practically every case. The functions of a town are changing all the time, in fact they are extremely fluid. The material form of a town, and its physical pattern is also changing but because of its physical immobility this occures at a slower rate or at least at later time; once existing it has to be adjusted to new content, and new functions. These last, although formative, and logically first are in turn influenced by the existing form and in the process of its adjustment they are themselves somewhat modified. In this dialectical movement and relation between fluid and changing content — functions, and the more stabile, and slowly evolving physical pattern — form of a town, lie all or at least the main difficulties of the establishing a comprehensive and easilly apprehendable typology of towns and urban networks.

This very short analysis of the relation between the two fundamental aspects of urban phenomenon may serve also as a starting point in the classification of towns on a comparative basis. The following system of analysis is therefore suggested. First the functions of a given town should be studied from the point of view of their character and stability, as well as their past, and the emerging new and possible elements; then, a short description of the physical urban pattern should be made including state of its complexity, basic physical elements, character of their mutual physical (spatial) connection, their relation to the geographical environment (site) and their past, present and future trends of change (evolution); finally the state of correlation between urban functions and the physical pattern should be properly defined.

Within the framework of this paper it is not possible to discuss in detail the problems involed in the first two steps of the proposed system. The morphological classification was presented by the author in an article written several years ago and recently published in *Czasopismo Geograficzne* [33 (1962)]. The third and last step should be however studied much closer.

Any effort to study the present correlation between functions and physical pattern or from implies a recognition of the existence to-day of, at least on a regional basis, specific urban functions. We have already stated that these functions are fluid and changing — now it is necessary to develop or even to modify this statement. The evolution of urban functions although continuous is not constant in its rate of change. Times of rapid and extensive changes are interspersed with periods of comparative stability. The reason is easy to apprehend, when we consider that, generally speaking, urban functions are directly derived from the social, economic and technical conditions of human life, in particular, of production and consumption. Whenever some kind of concordance between the material basis and the social superstructure of human society is evolved — the urban functions become stabilized; in cases of discordance between the two, their functions are liable to change. Times of change and in consequence of adjustment are always difficult both for planning and for the study of functions as well as of physical patterns. But let us assume that in certain areas or in some regions the urban functions are stabilized. In such a case two phenomena will follow: the given, stabilized set of urban functions will tend to create its own, specific forms and physical patterns and/or will adjust according to its needs older, already existing patterns into, transformed but equally specific forms. In some cases however the older forms for one or other reason will be left aside — derelict witnesses of the past. In this way for every period of social and economic stabilization we may expect the existence of three different types of physical urban forms or patterns: characteristic new, transformed older, and unchanged relicts of the past. With several periods of stabilization these types of correlation between functions and forms will naturally grow in number and complication. Times of transition — of quickened evolution or of sudden revolutions will always be characterized by an increased confusion or even complete break down in correlation between the two.

To understand better these rather theoretical conclusions let us look at the present correlation of functions and forms in the urban network of Poland, and find out whether it is already specific and typical.

As a results of the thousand-year process of evolution the urban network of Poland is both extensively and intensively, well-developed. Towns of several or even many functions prevail over those of a single function. But among the first there are those of many functions which are harmoniously developed — their rank as a central place, corresponds to their size, and there are those specialized towns in which one function dominates over others — their rank among central places is then much below that of their size. Their distribution may be interpreted in terms of the central place theory only on a rather narrow regional basis — for on the national level diversity of local urban networks is quite astonishing and although it may be easily described as a result of historical development, it cannot be explaineed within the framework of the theory as formulated at present. A detailed description was recently presented by me in *Przegląd Geograficzny* [34 (1962)] and will not be repeated here.

Urban functions were sharply modified about 1945 as a result of war devastations, changes in state territory, great war displacements and postwar migrations of population and by the revolutionary transformation in the social structure of the national economy. The rapid growth in the last few years, based as it is, on socialist economic planning is connected with the growing in extent and in intensity of industralization and urbanization processes. The specific shift in urban functions involves therefore a new increase in the importance of larger industries, especially of heavy industry as well as of state administration on national and regional basis. To this should be added the slow but steady development of all services and particularily those of culture and education. On the other hand the social and economic position of the retail trade (private shopkeepers) and of handicraft production (traditional craftsmen) has diminished among urban functions.

After almost twenty years the situation seems to be stabilized although with a slow but constant improvement in living conditions the relative position of the basic occupations (connected with town-creating functions) within the whole population is slightly decreasing.

From the morphological point of view the Polish towns at the end of the war may have been divided into three main classes. The first one contains towns in which single elements such as houses, public buildings, market place, streets, and others are integrated directly into the final pattern — the town itself. In the second the structure is already twofold — single elements form together specific individual units — districts, estates, perhaps "the city" and suburbs, which in turn are integrated into the town proper. In the third class the urban physical structure is threefold — elements are integrated into settlement units and these again are integrated into settlements of various types: towns, satelite towns, dormitory towns, industrial mining villages and others. In this class two main types may be distinguished: metropolitan cities and industrial conurbations. J. Gottesman in his recently (1961) published book introduced an even higher class of fourfold structure — "megalopolis" but such a type as yet does not exist in Poland.

Between all these classes — although clearly divided in definition — in reality there are wide transistory zones. Moreover in various places, and periods the correlations between these manifold structures and sizes and functions of towns may vary considerably. This correlation depends often on the commonly used techniques of urban development as well as on the socially accepted concept of the town itself and its community.

In the first class change in the functions of a town leads to the introduction of new single elements (e.g. a factory or an important public building), and abandonment or change of use for the old ones (e.g. of the big residence into a public building, of a market place into an open space or a parking). It may also mean as already mentioned, a change in its basic physical pattern. And this is happening now in Poland. Change in the functions of towns of single structure usually leads to the development of a new settlement unit constructed alongside the old one. At the same time however this last is also transformed by the changing use of its composing elements and by the evolving relations between the old and the new elements and settlement units.

In the second class changes introduced now by new functions are of a quite different character. It is only very rarely that structure is raised into a threefold pattern. Usually it means construction of new settlement units and the reconstruction of the old ones. Such reconstruction is however on a much larger scale than in the first case, and it is often connected with reconstruction or rather integration of the whole structure of the former town. A new, rational network of communications is therefore being developed replacing the old, haphazard one. In this way the whole structure is simplified on the basis of the provision for new functions.

A similar process takes place in towns of the third class, although on higher level. Again construction of new settlement units and in some cases of new settlements as well as the reconstruction of the existing ones leads to integration and reconstruction, involving simplification of the communication networks both on a local, regional, or even national scale. Such a reconstruction is in all cases undertaken on the regional level, involving however planning, financial means and technical efforts even on the national level. Good examples here may be found in the reconstruction of the national capital — Warsaw in the form of a metropolitan area, as well as in the redevelopment of the whole industrial and mining area of Upper Silesia including the neighbouring regional centres of Cracow, Częstochowa and Opole; and also in the construction of several practically new urban centres such as Kędzierzyn and Oświęcim, satellite towns such as Nowe Tychy or Pyskowice or new urban districts with corresponding industrial estates as for example Nowa Huta in Cracow or Raków in Częstochowa. Here we reach the point where the internal structure of a very large urban complex merges with the problems of the settlement network of the whole country. A plan and policy providing for the balanced and integrated development of all larger Polish towns was developed already in the year 1950-1951 in the State Commission for Economic Planning. It is rather surprising how well this plan has withstood all the politic, social and economic changes which have since taken place. The only serious modification had to be taken into account is rate of development of the towns on the Middle and Lower Vistula which was faster than forseen due to the increased importance of cheap, large and proper supply of water for industries.

This marks clearly the growing importance of the proper use of the geographical environment in one or other of its elements in the evolution of new urban forms and patterns; an importance clearly connected with techniques of urban development by settlement units, superseding a more traditional form with single elements.

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THE SIZE AND STRUCTURE OF CURRENCY CIRCULATION AS A TYPOLOGICAL CRITERION OF TOWNS

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Many landscape and socio-economic criteria have been applied in the existing typological divisions of towns, and in the period preceeding the Second World War the attention of geographers was focused mainly upon a classification based on the physiognomical features of towns and their topographical or geographical position and also, though to a lesser degree, on features of planning and spatial structure[1]. Features connected with the population residing in the area, including of course the question of the employment of the inhabitants and the functions fulfilled by settlement units, were investigated to a much smaller extent. It is true that the concept of so-called basic occupations of the population or town-creating occupations was formulated at the beginning of this century, and that in the interwar period population statistics also were sometimes used, but only since the last war has the typological analysis of towns been based largely upon these criteria. In the past twenty years the employment statistics have formed the basis for analysis of the functions and functional classification of towns.

The functional classification of towns, worked out during this period, have always been based upon employment statistics. Some authors, however, e.g. Ch.D. Harris, have based their classifications upon the proportion of people employed in various branches of the national economy [4], while others, e.g. H. Hoyt in the U.S.A., and P. Levchenko and V.G. Davidovich in the U.S.S.R., have analysed the structure of employment by applying criteria of town-creating occupations and services for inhabitants [1, 5, 8]. Lately J. Gottmann has classified the urban centres in the north-eastern U.S.A. according to the criterion of the number of clerical workers [3].

In Polish geographical literature functional divisions have been fully accept-

[1] Recently K. Dziewoński [2] presented the problems of morphological typology of towns in Poland, giving a short summary of earlier views on that subject.

ed since 1950, largely under the influence of the social demand expressed by institutions of spatial planning, and particularly by town-planners. A number of studies on this subject based upon the functions of towns defined by employment statistics has appeared in Polish geographical literature in recent years, and L. Kosiński in particular has published several articles[2].

Classifications based upon employment statistics considerably extend our knowledge of urban problems, and nowadays constitute a basic research instrument in the geography of towns. Typology based exclusively upon the structure of employment of the population is nevertheless incomplete and should be adequately integrated.

The criteria of suitable proportions in the structure of employment do not constitute a sufficient basis for classification, because, as is well known everywhere, towns thus classified into groups differ greatly among themselves. These differences arise partly from the fact that various important economic elements, such as the entire sphere of currency circulation, have been ignored. When such elements are taken into consideration, the essential features of a town can be defined more precisely and a range of sub-types can be distinguished within a differentiated functional group.

Financial problems have recently begun to assume more importance. J. Labasse, for example, has devoted a considerable work [7] to the role of capital in the formation of economic regions, and J. Gottmann has emphasized the question of incomes in his work on the north-eastern U.S.A. [3].

Studies of industrial towns in Łódź area carried out in recent years have shown that towns with a similar structure of employment, and related indices of various occupational groups and town-creating groups of population differ greatly in their physiognomical and socio-economic features, such as the degree of prosperity of their inhabitants, the size of their trade turnover, etc. As a result their roles in the national economy and in the spatial economic structure of the region are often basically different.

In the search for appropriate indices designating the degree of prosperity of the population, the size of trade turnover in a town, and its consequent role as a service centre, the ratio of the incomes of the population to their expenditures in this town, etc., we have come to the conclusion that the most adequate indices are these which define the size and structure of the currency circulation by the population of these towns. Financial activity is a very sensitive instrument in the assessment of all economic processes occurring in a town, and the currency circulation is a function of a number of different features which define the standard of living of the inhabitants, their economic activity, and in consequence also the economic activity of the town.

[2] In particular the article on the functional structure of Polish towns [6] should be mentioned.

Indices based upon elements of the currency circulation can form a proper basis for the classification of various kinds of towns. An attempt to apply such indices to the classification of industrial towns has been described in this paper. Some most essential features of the balance of payment of the population, in the form as they appear in bank reports and are thus relatively easily obtainable, have been included in the analysis. On the incomes side, there were all kinds of payments to the working population, such as basic wages and salaries, all kinds of fees and royalties, contributions from the workers' social fund in state factories operating on the basis of full economic accounting, etc.Profits of owners of private enterprises have not been included, as under the present Polish economic system they are very small and play hardly any role in the total earnings of the population in industrial towns. The structure of incomes was analysed in detail, however, as it constitutes an essential assessment of the numerical relations of all payments made to persons employed in enterprises by such budgetary units as state offices or institutions.

Pensions and all kinds of benefits and allowances in case of illness, accident etc. are a very important element in the incomes of the population, particulary the industrial workers.

The main expenditures of the population for the purpose of this analysis are retail and other purchases, payments for transport, postal and other services, entertainments, etc. Another essential element of the expenditures of the population is taxes and other duties payable to the Treasury.

The attempted topological analysis based on criteria of the size and structure of currency circulation has been carried out on the example of towns in two main industrial regions in Poland, i.e. Upper Silesian industrial district and Łódź industrial district. The first region developed thanks to rich deposits of coal, and possesses a large number of coal mines, iron foundries, non-ferrous metallurgical works, and all kinds of heavy metallurgical works, while the development of the second region was due more to political and economic good fortune than to the actual value of the local geographical environment. The growth there of the textile industry led to the redevelopment of small settlements into large and medium-sized towns. In both regions, however, many towns[3] have grown up whose main and almost sole function is now mining or industrial production.

These towns are characterized by high indices of population employed in town-creating occupations, since the local industry is not linked with services and supply for the local population, and also by the high percentage of people

[3] From a formal point of view, sometimes these are old towns, even mediaeval, but so much extended in the 19th century that they may be considered as founded in that period.

employed in industry, exceeding 80% of the towns' total employment. They differ greatly, however, in the range of occupational women's activities which greatly influence the index of the occupationally active population. While in Upper Silesian towns the number of employed women is about 30% of the total employed, in the Łódź district it exceeds 40%, and in certain towns amounts to almost 50%. In Upper Silesian towns the index of employed in proportion to the total population amounts to 40% or slightly more, in Łódź district it exceeds 45% everywhere and in certain towns reaches almost 50%.

Detailed analysis based upon currency circulation has been carried out for four towns, two in the Upper Silesian Coal Basin (Świętochłowice and Mysłowice) and two in the Łódź region (Pabianice and Tomaszów Mazowiecki). They are all of medium size. Świętochłowice and Pabianice having 58,000, Tomaszów Mazowiecki 50,000 and Mysłowice 42,000 inhabitants.

Świętochłowice and Mysłowice are generally considered to be typical towns of the Upper Silesian conurbation although as has been proved in the course of this analysis, they differ greatly in the size of the incomes and expenditures of their inhabitants. Pabianice is situated near Łódź and belongs to the Łódź agglomeration of industrial towns, while Tomaszów Mazowiecki is an industrial town (textile and chemical industries) situated within an agricultural area.

Classification by structure of wages

Towns can also be classified on the basis of the structure of wages and salaries earned by the inhabitants, the analysis of which produces rich material and enables towns to be differentiated from various standpoints. In the analysis of industrial towns whose main function is production, the assessment of their role as centres of various services is of greatest significance. The definition of their role as administrative centres can be an additional criterion.

If the basis of this classfication is the structure of the wages fund, i.e. the proportion of state-budget payments by financial institutions such as state offices and institutions in the total wages paid by state-owned enterprises operating on the basis of full economic accounting, the following three groups of towns can be distinguished:

(1) with low indices, from 5 to 7%, signifying an almost complete absence of state offices and institutions, with enterprises dominating the economic life of the town;

(2) with somewhat higher indices, from 8 to 10%, signifying that the existing state offices and institutions play some but not a very considerable part;

(3) with indices of 10 to 15%, or more indicating their role as important centres of state offices and institutions.

All the towns analysed are industrial in type. They fulfill no other function than that of production, and they are not administrative centres for neighbouring rural districts (they are not the seats of district local government).

Despite this they differ greatly in their wages structure. In the towns of Łódź area state offices and institutions play a greater role than in Upper Silesian towns. In Pabianice the wages and salaries paid by state officies and institutions amount to 8.9% of those paid by enterprises operating on the basis of full economic accounting, and in Tomaszów Mazowiecki 8.8%, whereas in Upper Silesian towns this proportion is much lower, amounting to 6.8% in Mysłowice, and to only 4.1% in Świętochłowice.

TABLE 1. INCOMES OF TOWN DWELLERS IN 1962

Towns	Average annual wage			Wages, salaries, pensions, allowances, bonusses etc. per inhabitant
	per person employed	per inhabitant	index of wages range	
	1	2	(1:2)	3
Pabianice	16,300	8,040	2.03	9,690
Tomaszów	17,500	8,180	2.14	10,160
Świętochłowice	20,300	8,408	2.40	10,170
Mysłowice	26,000	10,900	2.39	12,500

Consequently the Upper Silesian towns analysed, and particularly Świętochłowice, can be included in the first group of towns, in which enterprises predominate, while the towns of Łódź area will fall into the second group of towns, in which state offices and institutions play a minor role.

The ratio of average wages per person employed to the average wage per head of population is another criterion based upon the wage structure. This ratio is in fact the index of occupational activity of the inhabitants, and can be called the index of ,,wages range".

The various branches of industry represented in the towns analysed differ greatly in size of wages. The 1961 Statistical Year Book states that the average wage in coal mines was 2,822 *zloties* per month, in iron foundries 2,308, and in the power industry 2,142. In other branches of industry they were, however, much lower. In the chemical industry they amounted to 1,817 *zloties* per month and in the texstile industry to 1,466.

In the Upper Silesian towns under investigation the vast majority of the workers are employed in coal mining, the metallurgical industry, and power generating, and in Łódź area in the textile and chemical industries. It can be deduced that the average wage in Świętochłowice and Mysłowice is 30% higher than in Tomaszów Mazowiecki and 30–40% higher than in Pabianice.

This deduction is fully confirmed by analysis of the wage fund. If the average wage in Pabianice is accepted as 100, the respective indices are for Tomaszów Mazowiecki 107, for Świętochłowice 125, and for Mysłowice as high as 159. These great differences in average income are levelled, however, by a greater occupational activity of town dwellers in the Łódź area (a greater number of working women). In consequence average income per inhabitant does not greatly vary, but the indices of "wages range" do differ, and quite substantially. Towns around Łódź and Pabianice in particular are characterized by low indices, those of the Upper Silesia by high indices.

Even without reference to the analysis of the employment structure on this basis towns around Łódź can be assigned to the group of occupationally active towns, and Upper Silesian towns to those with little activity. The classification based upon the index of "wages range" can be of great service in the geography of towns.

Classification by size of trade turnover

Expenditure by the public and trade turnover in the town is the second element in an analysis based upon currency circulation. The important index which can be used to define the economic relationships in the town is the average turnover of retail trade and the average payments for various services. In Mysłowice, for example, the annual trade turnover per head of population is 10,770 *zloties*, but in Świętochłowice only 8,530. Towns in the Łódź area, however, are characterized by a high turnover, amounting in Pabianice to 9,260 *zloties* and in Tomaszów Mazowiecki to 9,720. At the same time in towns of the Łódź region much higher payments are made for all kinds of services. In Pabianice, for example, in 1963 services of small craftsment cost four times as much as in Świętochłowice.

Comparison of trade turnover alone provides an important basis for a comparative analysis, but the proper criterion to define the economic character of a town is the ratio of incomes earned by the inhabitants (in this case wages, salaries, pensions, allowances, bonuses, etc.) to the total sales by traders, and payments for all kinds of services within the town. Indices above 1 signify that payments to the public are exceeding their expenditure in the town and that a part is being spent outside the town. Such towns can be included in the group with passive exchange of goods and services. Świętochłowice with an index amounting to 1.05, and Mysłowice, with 1.08, are the typical examples. It may be interesting to note that Mysłowice, with relatively high indices of prosperity, is on the passive position.

On the contrary, indices below 1 signify that the revenues from trade sales and from services are exceeding the payments to the public. They reveal that some purchases are made by outside persons coming into the town, and that such a town is on an active position, as are, for example, Pabianice and Tomaszów Mazowiecki, with an index of 0.97.

The results presented show that the use of indices based on the size and structure of currency circulation among the urban public makes definition of the basic elements of the economic life of a town relatively easy, and that at thes ame time this definition is precise. This method reinforces the too-formal indices based upon emplyoment statistics and permits the classification of towns to be based on wider factors. The present analysis shows that among towns with similar occupational and functional structures, various types can be distinguished by analysis of currency circulation, and that these types will depend on the following criteria:

(1) the relative share of state offices and institutions in the total wages fund,

(2) the extent of the occupational activity of the inhabitants,

(3) the size of average income and the average expenditure on retail purchases and services in the town,

(4) the index of conditions in exchange of goods and services.

The analysis of currency circulation undoubtedly permits the introduction of many additional indices which can help to broaden the scope of classification.

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THE WAYS OF TRANSITION FROM THE THREE-FIELD SYSTEM TO MODERN FARMING AS CURRENTLY OBSERVED IN POLAND'S UNDERDEVELOPED REGION OF BIAŁYSTOK

WŁADYSŁAW BIEGAJŁO

The three-field system has played an important role in the development of agriculture in Poland. In spite of certain changes in some agrotechnical aspects and in social relations, this system has proved very persistent. It has survived for six hundred years as the main agricultural system in large areas of Poland, and only in the middle of the 19th century did it give way to multiple-course rotation farming.

The classic openfield system introduced into Poland between the 13th and 16th centuries was based as elsewhere upon the division of the village into arable, meadow, and pasture land. The principal forms of land use remained basically unchanged. The arable land was usually divided into three main fields, on which each husbandman had one or more plots. Within the main fields all husbandmen had to apply the same rotations and the same methods of land cultivation.

The first field, under winter grain, was entirely sown with rye or wheat according to the soil conditions. In the second under spring grain, barley, oats, summer rye, peas, and millet were cultivated. The third field was the fallow land used as the common pasture for cattle and sheep. Pastures within the boundaries of the village, woodlands, and also winter-crop stubble fields were also used by the whole community as grazing lands.

The three-field system with land lieing fallow and with a dominant cereal orientation was a progressive form and yielded satisfactory productive results in its initial stage, that is between the 13th and 15th centuries. However, when the *corvée* system developed and was consolidated in the 16th and 17th centuries in Poland [6], all its defects became apparent. The one-sided cereal orientation persisting through several centuries, the restricted use of organic fertilizers, the inefficient and careless cultivation of land by serfs with primitive implements such as the wooden plough (*araire*) and wooden harrow, led to a deterioration in soil structure, a decrease in crop yields, and fields thickly overgrown with weeds. The cultivation of the fallow land (bare fallow) was thus the only successful method of combating weeds.

The change from the three-field system to more progressive systems of total land utilization started in Poland in the late 18th century. This process is definitely connected with the period of franchise reforms introduced at different times in the three partitioned areas of Poland. All investigations, however proved [1, 3, 4, 5] that the classic three-field system broke up not so much because of the development of the forces of production and new implements of production as because of the introduction of new cultivated plants, particularly root crops such as potatoes, sugar-beet, mangolds, and papilionaceous plants (clovers, lucernes, lupines, etc).

The transition form the three-field system to modern farming was slowest in the territory of the Congress Kingdom controlled by Russia. Even in the mid-19th century in the territory of the Kingdom c. 82% of land was cultivated on the three-field system [4]. The franchise reforms 1961-1864 did not encourage the change from the traditional form of cultivation (with fallow land) to the modern crop-rotation system. On the contrary the surviving fragmentation of farms, common pastures, several commonages (pasturage in manor woodlands) prolonged and even consolidated the still-existing classic three-field system. Thus the process of its liquidation went on in the larger territories of the former Congress Kingdom until World War I and in the Białystok voivodship it survived even longer, through the interwar period and even until now, being connected with the consolidation of farm lands.

The tardy development of this voivodship makes it possible to analyse all the phases of transition from the classic three-field system to modern farming on the basis of observation of changes which are going on even to-day. During the research into the structure of agriculture in the Białystok voivodship [1-3] four variants of the three-field system, representing different stages in transition were distinguished.

1. The three-field system with fallow land is an example of the traditional and most primitive form, which has survived till today, in this territory in its classic pattern. This form of the three-field system, applied in an area of ca 45 thousand hectares, can be seen only in villages with fragmented fields (Fig. 1), particularly in the south-eastern part of the voivodship. The traditional division of the village into three field: fallow land, winter-crop, and spring-crop fields (Fig. 2) has been preserved. Compulsion in field cultivation i.e. the same sowing and use of the main fields, also remains in force. The close link between cultivation with fallow land and common pasturage on fallow lands, common pastures, and use of woolands is characteristic of these villages. This is reflected in the peculiar pattern of land tenure. We are here dealing with a coexistence or a compromise between individual ownership and common use of land. The arable land, which is individually owned, is

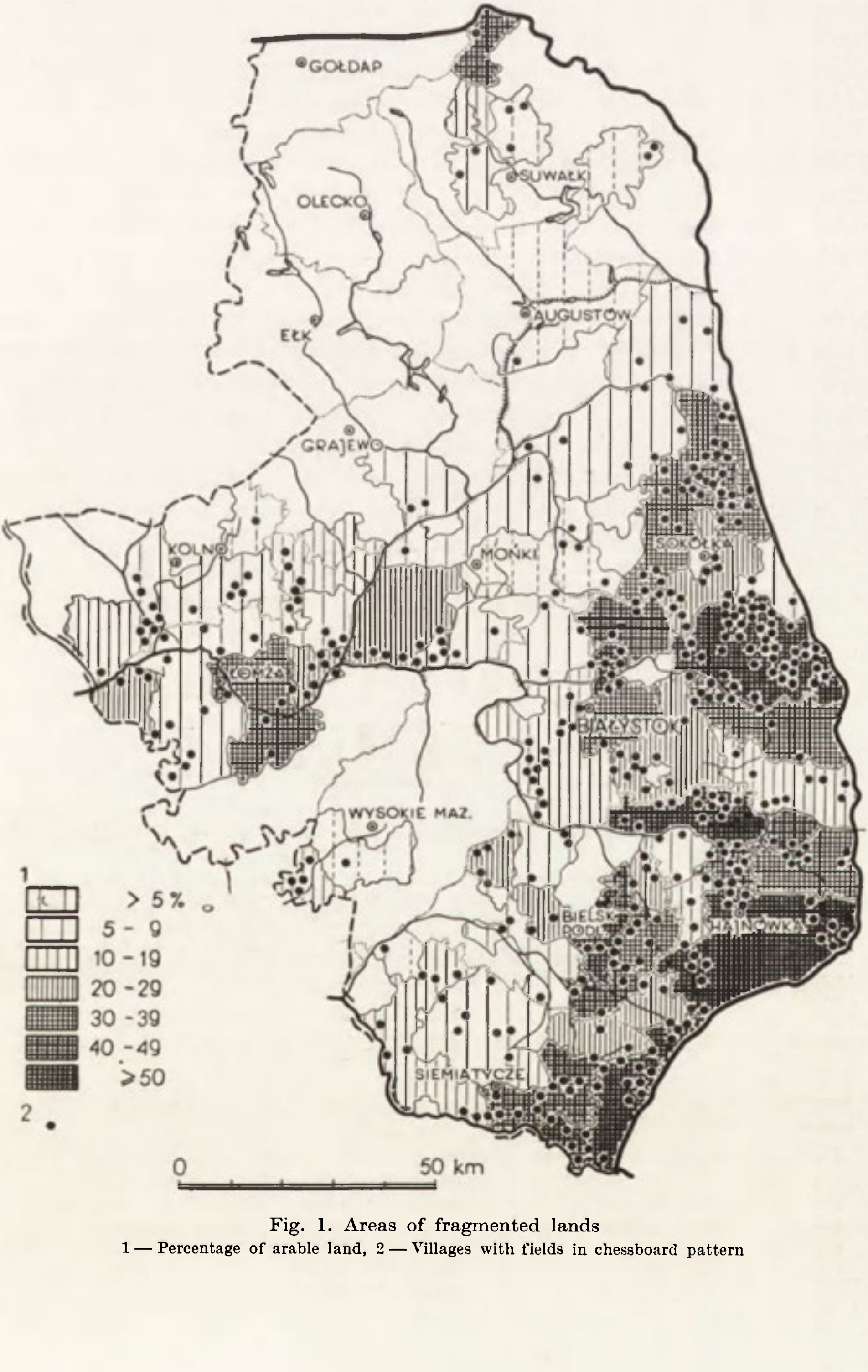

Fig. 1. Areas of fragmented lands
1 — Percentage of arable land, 2 — Villages with fields in chessboard pattern

used in common for pasturage when lying fallow, while all pastures and woodlands are common property. These ownership relations imply the existence of numerous features in the economic community such as methods and dates of land cultivation, sowing with uniform crops, dates of main field, work, etc.

The whole village is bound to apply regularized agricultural techniques. There is no first ploughing after the harvest, winter ploughing is done sporadically, and there are no after-crops, or inter crops. More careful is the cultivation of the fallow land which is ploughed and harrowed three times. Manuring is uniform and based mostly upon dung; it is used particularly on fallow before rye as well as before potatoes crops. The use of agricultural machinery is made more difficult by the fragmentation of farms. The main work (sowing, harvesting, potato-lifting) is done by hand, using very primitive implements such as scythes, sickles, or hoes. The average yield is achieved by hard manual work and is oriented towards producing cereals, particularly rye, and the breeding of cattle of sheep is extensive.

2. The three-field system in its transitional stage is to be found exclusively in villages with fragmented fields. Numerous features of the classic three-field

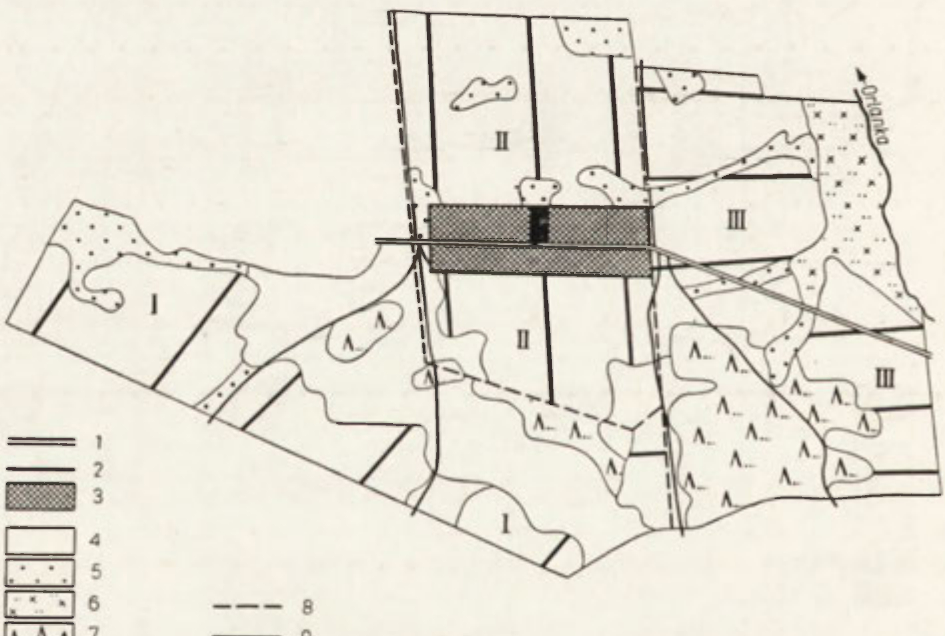

Fig. 2. Pattern of lands in the three-field system in the village of Holody, *powiat* of Bielsk Podlaski

1 — highways, 2 — field tracks, 3 — settlement buildings with orchard, and gardens, 4 — common pastures, 5 — grasslands used interchangeably as mown meadows or pastures (winter-crop and spring-crop fields used as meadows), fallow field as pasture, 6 — cultivated meadows, 7 — woodlands in commonuse, 8 — boundaries of fields, I st field — fallow land, II nd field — winter-crop, III rd field — spring-crop 9 — plots of arable land belonging to one farm

system still remain, e.g. division of the village into three main fields, and common pastures. The winter-crop field is sown entirely with rye or wheat and the spring-crop field with traditional crops such as oats, barley, buckwheat, millet, peas, flax, and today potatoes also.

The most essential change affects the fallow land, which is partially sown, either on irregularly occurring patches of better soil, or in a unified area (1/3 or 1/2 of the total) jointly designated for this purpose. The cultivation of part of the fallow land has very often eliminated the compulsory field cultivation, so harmful to agriculture, and has introduced some changes such as the introduction of first ploughing after the harvest, winter ploughing, and catch--crops or even after-crops. The partial elimination of fallow lands makes it possible to cultivate more fodder crops, and to end the customary grazing of cattle and sheep on fallow and stubble. It also takes part of the grassland between the fields out of common use. Lupines, serradella, as fodder or green manure, peas, and sometimes even early potatoes predominate among the crops introduced onto the fallow land.

3. The improved form of the three-field system is to be found in a few villages with fields still fragmented, and where the lands are divided into three fields. Despite the elimination of compulsory cultivation, it is customary to sow one field, traditionally called the "winter-crop field" with such a crop only (rye, wheat). The spring field is sown with cereals (oats, barley) and root crops (potatoes, sugar-beet). The third field, however, called the "green fallow" is sown entirely with papilionaceous plants (serradellas, lupines, clovers) destined mainly for fodder. Pastures are used in common and are as a rule deteriorated. Meadows, used as individual properties, however, are often cultivated. This form of the three-field system already reveals tendencies towards the gradual transition into rational crop rotation generally including root crops and leguminous plants, as well as cereals, as the three main elements. But the fragmentation of lands, and the resulting traditional practices such as common pasturage cause the new crop rotation to be somehow included in the traditional three-field system.

4. Three course rotation without fallow — the last stage of the decaying three field system — is to be found not only in Białystok voivodship but also throughout Poland. It extends beyond the villages with fragmented lands and the traditional division of the village into main cultivated fields, representing more or less a regular system of crop rotation, without the field compulsion and it is characterised by a limited number of cultivated crops: 1) root crops (mainly potatoes); 2) winter crops (mainly rye and wheat); 3) spring crops (oats, barley, flax, fodders).

This form of the three-field system is applied mostly in small farms of up to 5 ha with poor soils or in areas with a predominance of natural grassland. In the Biebrza and Narew *pradolinas,* in the Białystok voivodship and elsewhere where the form of three-field farming predominates common use of pastures is still occasionally found. The agricultural techniques applied are basically correct, the crops are carefully tilled, and the yields are satisfactory.

These four variants of the three-field system obviously do not exhaust all the various ways to be found in the transition from the three-field system to modern farming. The change very often takes place without any transitional stage. This is fully confirmed also by examples in the Białystok voivodship. With the consolidation of farms and elimination of the field compulsion, the three-field rotation has been replaced frequently by a four-course rotation similar to the "Norfolk" system widespread throughout Poland, and now predominating also in the Białystok voivodship. The currently applied system of four-course crop rotation has two variants, according to soil conditions:

I. on fertile soils
1. root crops (potatoes)
2. oats, barley with clover intercropped
3. clover
4. wheat, rye

II. on infertile soils
1. potatoes
2. oats, barley
3. papilionaceous plants (lupine, serradella).
4. rye

In the western districts of the voivodship (Łomża, Wysokie Mazowieckie, and Zambrów) the addition of one field cultivated with cereals has helped to bring a five-year rotation system into force.

These stages of transition from the classic three-field system to the modern system of farming as exemplified by the Białystok voivodship reveal only certain general regularities connected with the past and present day social and ownership as well as technical and economic conditions. Any change of these conditions may offer considerably greater possibilities of changing the agricultural system.

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GEOGRAPHIA POLONICA 2,1964

GEOGRAPHICAL TYPOLOGY OF AGRICULTURE. PRINCIPLES AND METHODS. AN INVITATION TO DISCUSSION

JERZY KOSTROWICKI

During the last 20—30 years there have appeared in many countries a considerable number of studies concerning types of agriculture elaborated both by geographers and agricultural economists. These studies reflect a growing interest in a more synthetic approach to the geography of agriculture.

Several years ago it was already pointed out that the results of these studies cannot be compared since the criteria for defining the types vary greatly [14] from country to country and even from author to author in one country. The confusion extends from terminology, through criteria, bases, to methods and techniques of classification.

The confusion does not seem very severe when one works within national boundaries of a small or even medium sized country or region. Ultimately one can always come back to the basic source material. But when one wants to make a larger synthesis covering several countries or regions, or the whole world, the difficulties are almost insurmountable, since the results of regional studies do not give an adequate bases for such a synthesis. No wonder that most of the larger typological syntheses are still based on general experience and intuition rather than on precisely determined scientific criteria.

At the same time there is a growing demand for such a typology of agriculture established on more exact and uniform methods and techniques. The need for food and other agricultural products of the growing world population requires the planning of a more rational use of land. Good effective planning requires however a good knowledge both of existing natural resources and conditions and how they are used, what in fact are the forms, ways and effects of their utilization [7] i.e everything that contributes to the notion of types of agriculture.

Because of the great diversity of world agriculture, the elaboration of its typology or even of the criteria of such typology is beyond the capacity of a single student or even a single scientific institute. To achieve it, the experience and effort of a large group of experts in agricultural geography of various countries and zones should be united, preferably within the framework of activities of the International Geographical Union.

The present paper does not pretend of course to solve the difficult and complicated problem of geographical classification of agriculture. Based on a number of studies by various authors from different coutries as well as on the experience of Polish agricultural geography and that of the present author, its aim is only to initiate the discussion on criteria, methods and techniques of such a geographical typology of agriculture.

TABLE 1. THE DIFFERENTIATING FEATURES USED BY VARIOUS AUTHORS TO DEFINE TYPES OF AGRICULTURE

I.	Land ownership and land tenure	P. George, N. Helburn
	Size of farms	N. Helburn
	Organizational forms of farms	P. George
	Amount of time spent off the farm by the operator	Generalized...
II.	The use of land	R. Dumont, L. D. Stamp, G. Blohm, D. Whittlesey, N. Helburn
	Crop rotation (and land rotation)	D. Faucher, R. Dumont, N. Helburn
	Tools and methods used in farming	D. Whittlesey
	Labour and capital ratios to land and to each other	R. Dumont, L.D. Stamp, N. Helburn, A. Rakitnikov
	Value of land	N. Helburn
	The complex of structures associated with farm enterprises	D. Whittlesey
	Intensity of land use	P. Dumont, P. George, D. Whittlesey, N. Helburn
III.	Value or volume of production (per unit area)	R. Dumont, G. Blohm, Generalized... N. Helburn, G. Studenski, A. Rakitnikov
	Balance of crop and livestock (share of particular sections of agric. production)	D. Faucher, L.D. Stamp, D. Whittlesey, N. Helburn, G. Studenski
	Labour efficiency (production per 1 person employed)	R. Dumont
	Processing and disposal of products	D. Whittlesey
	Commercial production per unit area	G. Studenski
	Degree of commercialization	N. Helburn
	Structure of commercial production	Generalized..., G. Studenski, A. Rakitnikov
	Specialization	R. Dumont, P. George, Generalized..., N. Helburn
	Uniformity versus non uniformity	L.D. Stamp
IV.	Balance of farm income and expenditure	G. Blohm, Generalized...,
	Level of living	N. Helburn

As has been already said the criteria and methods of such a classification adopted by various authors either differ from each other, or no definite and uniform criteria are followed, and very often the criteria and methods used are not even revealed by the author so that they may be deciphered only by careful analysis of his study.

Since a considerable number of typological studies of agriculture have been already published only the most representative examples of those which either define the criteria of such a typology or follow them in classifying the agriculture of more extensive areas have been selected by the present author as a starting point of the discussion. Studies both by geographers and agricultural economists representing France, Great Britain, Germany, United States and U.S.S.R. [1-6, 11-14], have been taken into account (Table 1).

The criteria listed above may be grouped in following four categories:

I. connected with ownership, tenure, subdivision and fragmentation of land

II. connected with forms and ways of agricultural land utilization

III. connected with agricultural production

IV. connected with income and standard of living of agricultural population.

Independently of how types of agriculture have been understood or called by various authors, the features of agriculture connected with the three first categories, have been considered as essential by most of them both geographers and agricultural economists, while only few authors have stressed the importance of the fourth category of criteria.

That seems to be quite obvious since the organizational, technical and productive features of agriculture represented by the three first categories are those which differentiate and determine type of agriculture, while a level of income or standard of living seem to be secondary and are subject to various influences of other than agricultural factors; for instance governmental policies, prices, taxation, debts as well as revenue drawn from non agricultural activities.

Taking into consideration only the three first categories the type of agriculture has been defined by the present author as; "shaped under given natural conditions, by given historical processes an ensemble of characteristic ways, orientations and effects of farming applied or achieved in agricultural establishments of definite social and land tenure conditions" [7, 8, 10].

According to this definition the natural and other external (social, economic etc.) conditions are treated as a basis and a background of man's agricultural activities. They do not provide a definition, however, of the type of agriculture since within the same or similar natural and other conditions depending on their internal features (forms of land tenure, technical equipment of farms, intensity of agriculture, orientations adopted etc.) different types of agriculture may develop. The external: natural, economic, social or technical conditions only determine or limit the possibilities of agriculture and help to explain why a given type of agriculture has been formed exactly on a given territory.

This definition makes it clear also that no type of agriculture should be defined based solely on one category of features. As has already been noticed [6, 10] areas of agriculture should not be considered to be of the same type, only because irrespective of other features the same crops are cultivated, in similar natural conditions. As N. Helburn rightly pointed out "Wheat farming in North Dakota... is much more closely related to cotton farming in West Texas than to wheat farming in Manchuria..." [6]. On the other hand, types of agriculture which differ from one another in many ways should not be considered to be alike simply because they are situated in the same state and are therefore subject to the same economic policy.

The pattern of features forming types of agriculture is dynamic. Its different elements are subject to continuous change, while the tempo of changes of particular features vary greatly. As a result in territories of old agricultural traditions various past and present features of agriculture have been superimposed on one another forming something like a stratification of features, which consequently form highly complex types of agriculture. On the other hand it is evident that where agriculture was introduced more recently or did not reach such a high level of development, then the types are much simpler.

Following on from these assumptions, basing on literature, on research work carried on in Poland, Hungary, Bulgaria and Yugoslavia, as well as on the author's own observations in various West European countries, U.S.A., Brazil, Pacific Islands and Java, the following features of agriculture which are grouped in three main categories are proposed for further discussion, as criteria of the geographical typology of agriculture:

I. Social and ownership features

Social and ownership relations in agriculture are comprised of all forms of relations between men in the proces of agricultural production i.e. forms of ownership (common, individual and social), relations between ownership and labour i.e. various forms of tenancy and labour supply (family, full time, part time farming, hired labour etc.), relations between labour and land (size of farms, configuration of farm area, fragmentation and dispersion of land lots, etc.), this is more or less what the French call *la structure agraire.*

The geographical investigation of these features for the purpose of agricultural typology does not cause any methodical difficulties. The only problem might be the lack of adequate informations in countries where detailed and reliable agricultural statistics are not available.

II. Organizational and technical features

In this group the most important seem to be the following three categories.

(a) organization of agricultural land,

(b) ways of farming i.e. organizational and technical means and practices aiming at obtaining agricultural production and the maintainance of soil fertility.

(c) intensity of the applied means and practices i.e. intensity of farming.

The organization of agricultural land is expressed first by its division into main uses and then by their subdivision according to their further designation. The methods of research along this line are relatively simple end easily yield quantitative results. The comparative studies of more than one country may be only hamperd by the divergence of agricultural statistics, various groupings of particular land uses or crops, very often being non uniform or inconsistent. The discussion of this problem as well as an attempt to group particular crops according to their agronomic or economic features has been presented by the author elsewhere [10].

The investigation of proportions between various forms of land uses and then between various groups of crops, as well as the distinguishing of the dominant or co-dominant crops in each group based on agricultural statistics checked by field observations, exhaust the problem adequately.

Investigations as to the ways of farming are more difficult and yield less easily quantitative results, since means and practices adopted to obtain agricultural production are very numerous, many of them being connected only with particular crops. The typological importance of them vary greatly, very often changing with the level of agriculture or other circumstances.

Among all these features the most significant typological importance is very often ascribed to crop rotation, which is supposed to unify the features of all other categories. Therefore particularly in French and Russian studies the crop rotation is often treated as a leading feature, determining the so-called agricultural system. Investigations into crop rotation systems are however a tedious job since there are no statistics to supply the adequate data. At the same time it is not certain whether on the areas of higher level and more intensive agriculture crop rotation systems give a sufficiently good sample of farming systems or even ways of farming alone. Therefore in most of the cases it should be supplemented by various forms of evidence, defining the technical level of agriculture as for instance the amount and kind of fertilization, degree of mechanization, irrigation practices as well as in more primitive agricultural systems by the methods of tilling the land (hoeing, ploughing, etc.), of plant propagation (vegetative, by seeds etc.) etc.

The notion of intensity of agriculture is interpreted in different way and often confused with productivity. In the present paper the intensity of agriculture is understood as a volume of inputs (labour and means of production) used per unit area, taking into account not only their ratio to the land but also the structure of inputs, and particularly the labour and means of production ratio, all of which are essential as typological features.

There are many methods of measuring intensity. Most of them however and particularly the most exact ones are so labour absorbing that it is impossible for them to be used in any study of a great number of territorial units.

In this situation the student is compelled to base his research either on symptoms of intensity i.e. the share of more intensive elements of farming, or by the summing up of the particular elements of farming, measured with special coefficients of intensity, or on several intensity indexes considered as representative ones, as for instance a number of persons employed in agriculture per unit area, number of draft animals per unit area, number of tractors per unit area, etc. (discussion see [10]).

A generalizing notion of all organizational and technical features of agriculture is the system of farming (used sometimes also as synonymous with type of farming). To the definitions and study of systems of farming particular attention has been paid in Germany and also in U.S.S.R. and France. In most of the cases either some selected organizational and technical features of agriculture (utilization of land or land utilization and intensity) have been used or else systems of cropping and systems of livestock breeding and then inside those branches of agriculture various particular systems have been separately defined.

III. Economic features of agriculture

The common basis for investigation of the economic features of agriculture such as agricultural productivity, efficiency, marketability as well as farming orientations is agricultural production. To establish the agricultural production first, whether gross production or the gross production minus products used inside the agricultural establishment for productive purposes (seeds, manure etc.) i.e. the net production is to be adopted as a basis from which further evaluations should be decided. Then what kind of units should be adopted to measure the agricultural production. For various reasons (discussion see [10]) despite all its defficiences the author is inclined to accept gross rather than net production. As to the measuring units, despite all their advantages, monetary units as based on prices and therefore subject to constant variations in time and space have been considered unsuitable for comparative areal studies, particularly when several countries are concerned. Despite several defficiences (see discussion [10]), more appropriate for this purpose seem to be conventional units based on natural criteria as for instance the so called grain units widely used in Central European countries.

The amount of agricultural production per unit area defines the agricultural productivity, the commercial production per unit area the marketability, the share of commercial production in gross (or net) production — the degree of commercialization. A very important feature of this category but at the same time very difficult to evaluate is an output-input ratio (agricultural efficiency) very often replaced in concrete studies by much simpler but less significant index of agricultural production per one person employed in farming (labour efficiency). The agricultural production serves also as a basis for defining the farming orientation established on the proportion first between plant and animal production, then on the share of particular sections of plant and animal production in gross (or net) agricultural production and finally on the dominance, co-dominance or prevalence of particular elements in each section (method of defining farming orientations see [10]). In the same way the orientations of commercial production can be determined. It should be stressed however, that the investigation of commercial production only, by no means exhausts or replaces the investigations of the agricultural production as a whole, since in most countries a commercial production constitutes only a smaller or larger part of total agricultural production and its structure differs greatly.

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Aforesaid considerations lead to the conclusion that the most characteristic features of the type of agriculture are the following ones.

I. Social and ownership features:

1. share of particular forms of land ownership (common, individual, social etc.),
2. share of particular forms of labour supply (family, hired, tenancy etc.),
3. size of farms and their fragmentation.

II. Organizational and technical features:

1. organization of agricultural area (proportions between land uses and between particular crops),
2. ways of farming (crop rotation including land rotation, fertilizing, mechanization, irrigation, terracing etc.),
3. intensity of means and practices adopted (intensity of farming).

III. Economic (Productive) features:

1. agricultural productivity (gross or net production per unit area),
2. labour efficiency (gross production per one person employed in agriculture),
3. marketability (commercial production per unit area, share of commercial production in total production),
4. farming orientation (and eventually the orientation of commercial production).

The list of typological features presented above has been evolved based largely on European experiences. The experiences from other areas will enlarge it, possibly adding some other features overlooked here or may indeed make doubtful the universal importance of some features mentioned above.

Not all the features presented above can be expressed in quantitative measures, and some of them may be expressed quantitatively only for the countries possessing detailed and reliable agricultural statistics. These or other characteristic typological features established finally in discussion should indicate however the directions of investigations even in countries having no such statistics where their definition is to be based only on observations and estimates and seldom yields quantitative results. Finally the full list of differentiating features can not be used in macroscopic studies covering very large areas, where the number of features investigated would have to be possibly reduced. It should be noted however that in doing so no one of the three main categories should be omitted. It is therefore desirable for comparative purposes to establish a set of features, measures and indexes which holds good for every country, every type of agriculture and every level of investigation, and which migh be eventually enriched or developed according to the local conditions when moving to more detailed investigations of less extensive areas.

The last problem, I want to discuss here, is a method of integration of all the information and quantitative indexes obtained which represent various typological features, in order to reach the final typological synthesis. Until now most of the students, particularly those dealing with larger areas, synthetize their factual material intuitively perhaps, based on their personal experience, either ascribing a deciding importance to a small number of selected features or indexes, or by superimposing the cartographic picture of the distribution of particular features and ascribing the deciding role to the coincidence of their territorial ranges. At the same time a number of quantitative methods elaborated by mathematicians and non mathematicians are in use in various disciplines (anthropology, plant sociology etc.) to measure similarities or average differences between various phenomena. Some of them have been used also for studies of agriculture, not always with the best result. None of them howover have been checked in the typological investigations of agriculture.

Apart from establishing the most essential typological features, measures and indexes, the next problem which should be solved if geographical typology of agriculture is to be based on certain and objective criteria is the establishing of exact methods of integration of those features.

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THE ORIENTATIONS IN AGRICULTURAL PRODUCTION OF POLAND

Roman Szczęsny

The orientation in agricultural production is one of the basic features of a geographical type of agriculture. This is why special attention has been drawn to this problem in the ensemble of studies concerned with the typology of agriculture in Poland.

The term orientation in agricultural production is taken to mean here the general inclination of the agriculture of a given region to produce certain definite agricultural products. Its definition is based on the proportions between the vegetable and animal production, and on the predominance of some definite sections within those two branches of agricultural production. Productivity of agriculture has been taken as a basis for defining orientations of agricultural production. In the present work this has been calculated by summing up the agricultural output of the given area during the period of one given year, regardless of its destination (gross production) and then dividing it by the agricultural acreage.

Vegetable production is in the first place the total crop production plus the vegetable production obtained from natural meadows and pastures, green manures etc.

Animal production includes: production of both meat stock for slaughter and other animal production such as milk, wool, eggs; in the present work neither the natural increase of livestock nor the differences arising from its growth in weight have been taken into consideration, as these elements being difficult to define are finaly registered also in the form of meat, milk etc. although not necessarily during the same year.

Thus, although establishing the gross vegetable production provides no special difficulties, calculating total animal production is more complex largely because of lack of exact data concerning the totals of production of the different species of animals, particularly within the limits of smaller administrative units.

Thus estimate indices have had to be applied in calculations of the range of animal production, namely a "slaughter index" (i.e. the proportions between the livestock slaughtered during the year and the total number of the particular species of animal), and the average weight of the meat livestock; this only gives approximate values of production, of the particular elements of animal production. Again the total of production of agricultural products, has been summed up using as the common comparable measure a grain unit.

Thus the gross agricultural production, in the defined sense of the meaning was calculated for each of the *powiats* in Poland in 1938 and 1958 using the following formula:

$$PgA = [(c_1 \times g_1) + (c_2 \times g_2) + \dots + (c_n \times g_n)] + [(hb \times ib) + (hv \times iv) + (hm \times im) + (hp \times ip) + (hs \times is) + (hs \times iw)],$$

where:

PgA	total of agricultural production
c	production of different crops
g	grain units for different crops
hb	number of cattle (over 1 year old)
hv	number of calves (upto 1 year old)
hm	number of milking cows
hp	number of pigs
hs	number of sheep
ib	calculative index for cattle (slaughter index × average weight × grain units)
iv	calculative index for calves (as above)
im	calculative index for milk (milk in liters from 1 cow × grain units)
ip	calculative index for pigs (as for cattle)
is	calculative index for sheep (as for cattle)
iw	calculative index for wool (total of wool from 1 sheep × grain units)

Most essential in any definition of the orientation in agricultural production is the grouping of the particular elements. The following groups have been assumed in the present work, although the author is fully aware of a certain inconsistency in the formation of the groups.

A. Vegetable production:
1. Grain crops — wheat, rye, barley, oats, buckwheat and millet, mixed grain, edible fodder crops.
2. Edible root-crops — potatoes, vegetables.
3. Industrial crops — sugar-beet, rape-seed, flax, hemp, sunflower, poppy-seed, etc.
4. Fodder crops — clover, lucerne, sainfoin, serradella, vetch, sweet lupine, maize, mangolds, meadows, pastures, straw.

B. Animal production:
   5. Cattle — beef stock, veal stock, milk.
   6. Pigs — pork stock.
   7. Sheep — mutton stock, wool.

In order to distinguish the orientations of production the following basis has been assumed as to the proportion between vegetable and animal production (in percentages of the total)

1. Leading orientation either vegetable or animal	over 60%	in form of vegetable or animal production
2. Mixed orientation either vegetable or animal	— 40-60%	
3. Accompanying orientation	— 20-40%	

Having once established the proportions between vegetable and animal production, then within the range of vegetable and animal production the leading, mixed and accompanying orientations have also to be established using the same principles as for instance: grain-root, industrial, fodder, or else cattle, pig and sheep orientations.

Within the different groups of vegetable or animal production other additional inclinations in a narrower sense of the meaning have been distinguished which enable a more precise definition of the orientation in agricultural production and after which the established orientations of production have been called. On this basis the following orientations have been distinguished:

A. In vegetable production:
   1. Among grains crops — wheat, rye, barley, oats, mixed corn.
   2. Among edible root-crops — potatoes, vegetables.
   3. Among industrial crops — sugar-beet, rape, flax, hemp, tobacco.
   4. Among fodder crops — clover, serradella, lupine, meadows, pastures.

B. In animal production:
   5. In cattle breeding — milk and meat (beef and veal).
   6. In pig breeding — meat (pork).
   7. In sheep breeding — meat (mutton) or wool.

Sometimes the share of particular elements of production in a given group is very similar or equal, e.g. wheat and rye, rye and oats, potatoes and vegetables etc. If this is the case the orientation has to be defined as mixed, for instance rye — wheat one.

Thus to be more precise a mixed orientation is when in a given group the production of the second element amounts to over 75% of the production of the first one. A somewhat different procedure has been adapted in the case of edible root crops when defining a mixed potatoe-vegetable orientation. As, the area covered by vegetable production is often lower than in reality, particularely in sub-urban zones, a given group has been defined as mixed when the total of vegetable production amounted to only 50% of the production of potatoes.

In order to avoid the accumulation of too large a number of accompanying orientations in both vegetable and animal production, such accompanying orientations which do not reach the share of 15% of the total production have been eliminated. Thus a clearer image of the orientations in agricultural production is obtained.

Orientations in agricultural production defined in this manner have been grouped together on a basis of both quantitative and qualificative predominant features. Secondary features have served as a basis for distinguishing the different modifications and variants within the main orientations, resulting from either social-economical conditions or the geographical environment.

These groups have served as a basis for further definition of main orientations in agricultural production encountered in Poland. At the same time the gross production in grain units per 1 ha of arable land has been defined i.e. the productivity of agriculture grouped in the following order:

1. Low productivity	below 24
2. Medium productivity	24-32
3. High productivity	32-40
4. Very high productivity	above 40

On that map of orientations in agricultural production, productivity of agriculture has been marked with different intensity of colour (full intensity— high productivity, 1/2 intensity — medium productivity, 1/4 intensity — low productivity) thus depicting territorial differentiations of productivity of agriculture in Poland in 1958.

In 1958, in Poland, two main groups of agricultural orientations have been distinguished and these in turn are divided into 17 main orientations of production, namely:

I. Orientations showing a prevalence of vegetable production over the animal (when vegetable production amounted to more than 60% of gross agricultural production and breeding of livestock was only an accompanying orientation amounting to 20-40% of the gross agricultural production) were found troughout Poland with the exception of the southern voivodships (of Rzeszów, Kraków, Katowice).

II. Mixed vegetable-animal orientations (where animal and vegetable production amounted both to 40-60% of gross agricultural production) occured in southern Poland.

In none of the *powiats* the prevailing animal orientation (where animal production was over 60% of the gross production) has been found.

The orientations of agricultural production and the areas in which they predominate in Poland can be classified as follows:

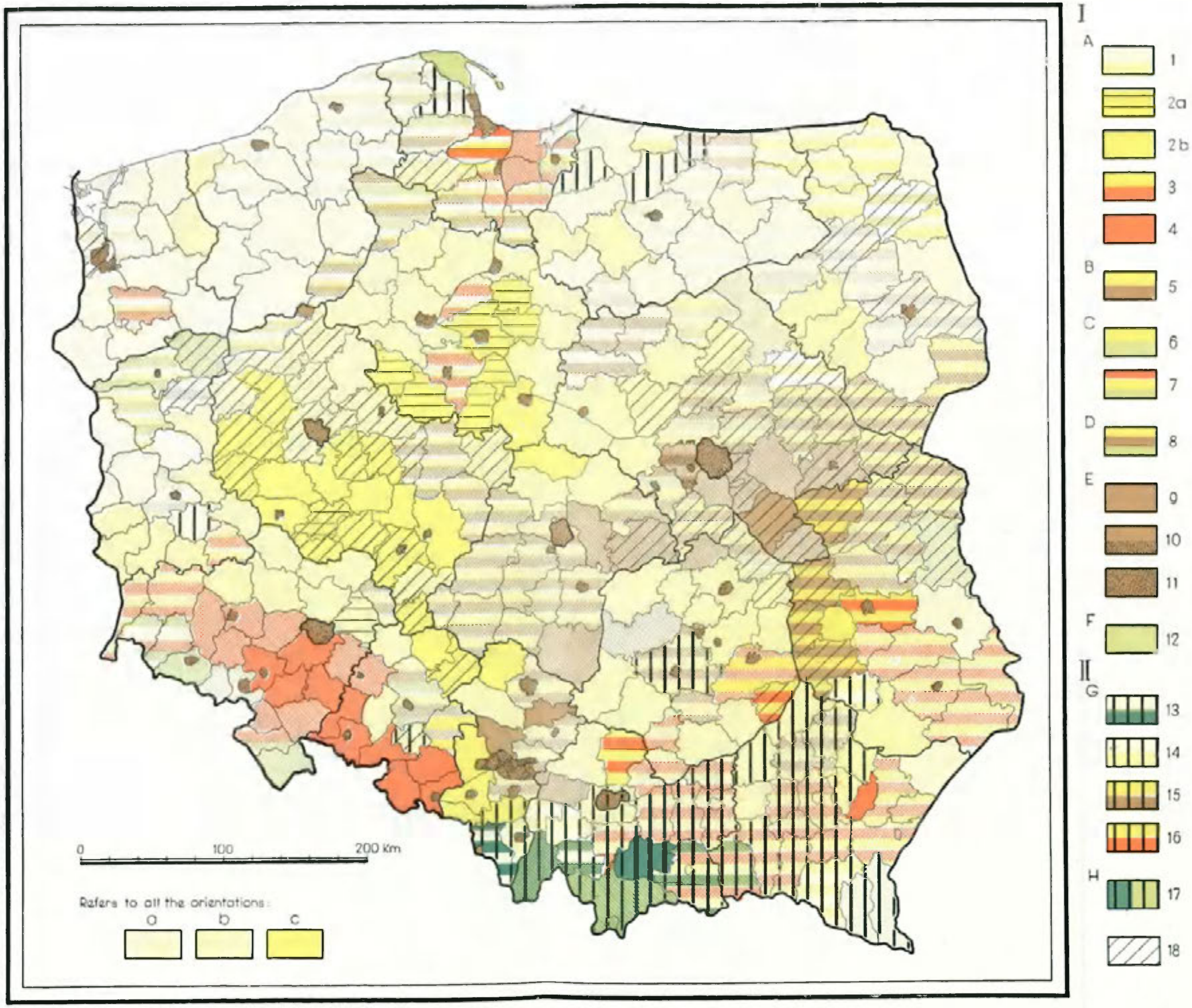

Fig. 1. The orientations in agricultural production of Poland

A. Grain orientations, 1 — Rye-oats with potatoes, fodder crops and the raising of dairy cattle, 2a — Rye with potatoes, fodder crops and the raising of dairy cattle (and pigs), 2b — Rye with sugar-beet and the raising of dairy cattle, 3 — Rye-wheat with sugar-beet or potatoes, as well as clover and the raising of dairy cattle, 4 — Wheat with sugar-beet, potatoes, clover, and the raising of dairy cattle.

B. Grain-root-crops orientation, 5 — Rye-potatoes with the production of fodder crops and the breeding of dairy cattle (and pigs).

C. Grain-fodder orientations, 6 — Rye-fodder (clover, serradella, meadows) with potatoes and the raising of dairy cattle, 7 — Wheat-oat-meadows with the raising of dairy cattle.

D. Grain-root-crop-fodder orientation, 8 — Rye-potatoes-fodder with the breeding of dairy cattle (and pigs).

E. Root-crop orientations, 9 — Potatoes with rye, meadows, and the breeding of dairy cattle (and pigs), 10 — Potatoes-vegetables with rye, clover and the raising of dairy cattle, 11 — Vegetables with the breeding of dairy cattle (and pigs).

F. Fodder orientitions, 12 — Meadows with grains (wheat with oats, rye), potatoes and the raising of dairy cattle.

G. Grain-dairy orientations, 13 — Oats-milk-clover with potatoes, 14 — Rye-oats-milk with potatoes and clover, 15 — Rye-milk-potatoes with meadows, 16 — Rye-wheat-milk with potatoes and clover.

H. Fodder-dairy orientation, 17 — Fodder (clover, meadows)-milk with oats and potatoes, 18 — Additionally pig breeding. Level of productivity, a — Low, b — Medium, c — High.

I. Vegetable orientations

A. Grain orientations

1. Rye-oats with potatoes, fodder crops (where clover or meadows prevail) and the raising of dairy cattle — of low productivity.

This orientation occurs in only a few *powiats* in North-East Poland.

2. a) Rye with potatoes, fodder crops (where clover, serradella and meadows prevail) and the raising of dairy cattle (and pigs) — of low, medium or high productivity. This orientation is found in Poland in two regions: (a) North-West (voivodship of Szczecin and Koszalin), — of low productivity and (b) the middle-West (voivodship of Zielona Góra, Poznań, Bydgoszcz with the exception of the Central part, Western territories of the voivodship of Olsztyn, Katowice, Warszawa and North of Wrocław, Opole and Kielce), — of medium and high productivity.

b) Rye with sugar-beet and dairy cattle breeding — of high productivity.

This orientation occurs mainly in the Central part of the voivodship of Bydgoszcz.

3. Rye-wheat with sugar-beet or potatoes as well as clover and the raising of dairy cattle, — of medium and high productivity.

This orientation occurs mainly in the South of the voivodship of Lublin and the voivodship of Kielce, in the West of the voivodship of Wroclaw as well as in the territory of Żuławy (Vistula Fens).

4. Wheat with sugar-beet, potatoes, clover, and the breeding of dairy cattle, — of medium and high productivity. This orientation occurs mainly in the center of the voivodship of Wrocław, of Opole and in Żuławy.

B. Grain-root-crops orientations

5. Rye-potatoe with the production of fodder crops (where clover, serradella and meadows prevail) and the breeding of dairy cattle and pigs, — of medium and high productivity. The main regions where this orientation occurs are: a) central Poland (voivodship of Łódź, part of the voivodship of Katowice and the Eastern part of the voivodship of Poznań), with an accompanying orientation of the breeding of dairy cattle, b) East Poland (South-Eastern part of the voivodship of Warszawa, Northern and Western part of the voivodship of Lublin), with an accompanying orientation of the breeding of dairy cattle and pigs.

C. Grain-fodder orientations

6. Rye-fodder (where clover, serradella and meadows prevail) with the production of potatoes and the breeding of dairy cattle, — of low and medium productivity. This orientation mainly occurs in the Southern part of the voivodship of Olsztyn, the Eastern part of the voivodship of Koszalin and the Northern part of the voivodship of Zielona Góra and Szczecin.

7. Wheat-oat-meadow orientation with the breeding of dairy cattle, — of medium productivity.

This orientation occurs mainly in some of the *powiats* in Sudety Mts.

D. Grain-root-crop-fodder orientations

8. Rye-potatoe-fodder (where meadows or serradella prevail), together with the breeding of dairy cattle (and sometimes pigs), — of medium productivity.

Occurs on the area of a few *powiats* of the voivodship of Warszawa.

E. Root-crop orientations

9. Potatoes with the production of rye, meadows and the breeding of dairy cattle (or else of dairy cattle and pigs), medium and highly productive.

Occurring mainly around Warszawa, Łódź and Upper Silesian Industrial District.

10. Potatoe-vegetables with the production of rye, clover and breeding of dairy cattle, of medium productivity. This orientation is typical for the sub-urban zone of Warszawa, occurs mainly in the *powiat* of Pruszków.

11. Vegetables together with the production of rye, fodder crops (clover and meadows) and the breeding of dairy cattle and pigs of medium and high productivity.

This is in general a sub-urban orientation which occurs within the limits of individual towns.

F. Fodder orientations

12. Meadow together with the production of grains (where rye prevails, wheat and oats), potatoes and breeding of dairy cattle, of low and medium productivity.

These orientations occur mainly in the *powiats* of Sudety Mts. and others scattered all over Poland (e.g. Wolin, Puck, Ostrołęka, Włodawa, Strzelce Krajeńskie), having large areas of natural meadows and pastures.

II. Mixed vegetable — animal orientations

G. Grain — dairy orientations

13. Oats-milk-clover together with the production of potatoes of medium and high productivity.

These orientations occur in some Carpathian *powiats* (Cieszyn and Sucha).

14. Rye-oats-milk with the production of potatoes and clover, of low and medium productivity.

These orientations occur in a few *powiats* in the South of Poland (Sanok, Wadowice, Oświęcim, Janów).

15. Rye-milk-potatoe with meadows, of medium productivity.

Occurs in only a few Northern *powiats* of the voivodship of Rzeszów (Nisko, Tarnobrzeg) and in the *powiats* of Kielce and Wejherowo.

16. Rye-wheat-milk together with the production of potatoes and clover (meadows), of medium productivity. This orientation occurs mainly in the central areas of the voivodship of Rzeszów, North of Kraków, and in the *powiat* of Bartoszyce.

H. Fodder-dairy orientations

17. Fodder (clover or meadows)-milk with the production of oats and potatoes, of low and medium productivity. This orientation occurs mainly in the Eastern Carpathian *powiats* of the voivodship of Rzeszów and Kraków.

The principal orientations of agricultural production may be divided again into numerous sub-orientations with only minor differences between them, namely the prevalence of these or other crops within the accompanying orientations or else the level of agricultural productivity.

Similar studies were carried out for 1938 with the intention of establishing and pointing out the changes which have taken place in orientations, and the productivity of agriculture, during this twenty-year period on the present day territory of Poland.

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ON PROBLEMS OF THE INTERRELATIONS BETWEEN INDUSTRIAL PLANTS AND GEOGRAPHICAL ENVIRONMENT

Łucja Górecka, Jerzy Grzeszczak

During recent years the Department of Industrial and Transportation Geography at the Institute of Geography of the Polish Academy of Sciences carried out research under the leadership of Professor S. Leszczycki on the interrelation between some selected branches of industry and geographical environment, and particularly on links between industrial plants and the raw material bases at their disposal. These investigations included above all the building-material industry, as the branch in which links between production and geographical environment are the closest. The first priority was given to the cement and brick industries[1]. First of all these investigations were the subject of two doctorate dissertations, presented by the authors of this article.

One of the principal aims of the research undertaken was the attempt at a formulation of a quantitative definition of mutual interrelations between the industries under analysis and the geographical environment. The tendency to formulate the most precise possible quantitative definitions, and to find out methods of making such definitions for the interrelations analysed, was an element linking the researches carried out.

During the investigations the most interesting results were achieved for the following problems:

(1) the influence of the deposits of mineral raw materials on the location of plants, their size and range of production,

(2) the influence of natural factors on production costs,

(3) the influence of exploitation of deposits and processing raw materials on changes in the geographical environment of the region.

[1] The term „brick-industry" indicates in this article the production of so called red-building ceramics only.

The influence of the deposits of mineral raw materials on the location of plants, their size and range of production

Analysing the degree of dependence between the location of a cement mill or a brickworks, and the existence on the spot of deposits of the appropriate mineral raw materials, it is necessary to take into consideration the phenomenon of substitution now in progress, as more and more often subsidiary raw materials (e.g. blast-furnace slags in cement production) are in use together with traditional natural raw materials. This phenomenon, resulting from technological progress, does not diminish the demand for natural raw materials as the cement and brick production generally increases in quantity.

TABLE 1. PRODUCTION OF BRICK-INDUSTRY PRODUCTS IN POLAND ACCORDING TO THE TYPE OF RAW MATERIALS AND THE SIZE OF THE BRICKWORK

Geological characteristics of the raw material	Brickworks according to the annual production in millions of ceramic units										Total*	Annual average**
	less than 1	1—2	2—3	3—4	4—5	5—7,5	7.5—10	10—15	15—20	more than 20		
	in percentages of the total production of the given group of brickworks											
Quaternary formations:												
Alluvial	0.3	5.2	6.4	7.4	9.6	10.2	20.6	14.8			8.7	4.4
Loesses and looss clays	18.6	9.7	8.1	4.3	7.8	3.3					5.1	2.0
Boulder and waethering clays	41.3	37.7	24.1	21.5	25.1	7.8	4.5				17.0	2.0
Pleistocene loams and silts	8.6	13.7	17.0	25.1	18.5	26.2	15.5	20.4	16.6	36.8	20.8	4.0
Tertiary formations:												
Pliocene loams	4.5	11.3	21.8	16.6	11.0	4.7	7.3	19.2	15.4	46.4	14.5	3.8
Miocene loams	5.5	5.6	9.9	11.1	14.3	18.9	23.3	31.1	35.7	16.8	15.9	4.8
Oligocene and Eocene loams and shales	0.9		2.4	1.0	1.9	3.2	3.7				1.7	3.7
Mesozoic and Palaeozoic formations:												
Cretaceous, Jurassic and Trias loams and shales	1.3	3.3	3.7	5.1	3.9	7.3	16.3		16.8		5.4	5.0
Permian and Carboniferous loams and shales		2.7	1.9	4.7	5.0	18.4	8.8	14.5	15.5		7.8	5.4
Undefined formations	19.0	10.8	4.9	3.2	2.9						3.1	1.1
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	3.3

* Percentage of the home brick production based upon a given raw material.

** Annual average of the volume of production in a brickworks processing a given raw material, in millions of ceramic units.

The increase in the volume of production, together with its simultaneous concentration in big or at least medium-sized plants, cause demands for localization of these plants to grow stronger and stronger in proportion to the volume of raw material deposits. The quality of raw materials becomes more and more important as a result of the transformation of the standard of output (in brick production e.g. the percentage of thin-wall and hollow products, made of a higher-quality raw material).

Some of these interrelations are illustrated in Tables 1 and 2, presenting the influence of various raw materials on the volume and range of brick production. The figures included in the Tables justify a statement that as the volume of production increases and the standard of output of a brickworks becomes more and more differentiated, the role played by quaternary raw materials decreases but the significance of older-formation compositions increases. The reasons for this fact should be sought in a better (because of the increased scale of production and range of produced goods) selection of deposits (and raw materials found in them) from the viewpoint of their greater wealth and qualitative features. In the category of the brickworks with an annual production of over 7.5 million ceramic units, the decisive role of pre-quaternary raw materials, which in most cases are much richer and more adaptable to brick production, is clearly visible. The production of all more valuable brick products is based predominantly on these raw materials. Pliocene and Miocene loams, for instance, taken together, are the basis of the almost three quarters of the Polish production of tiles.

TABLE 2. PRODUCTION OF BRICK-INDUSTRY PRODUCTS IN POLAND ACCORDING TO THE TYPE OF RAW MATERIALS AND RANGE OF PRODUCTS

Geological characteristics of the raw material	Range of products									
	Brick						Hollow brick	Tile	Draintile	Other products
	full	cavity	perforated	clinker	semi-clinker	firebrick				
	in percentages of the total production of a given product									
Quaternary formations										
Alluvial	10.0	5.2						11.9	7.4	40.5
Loesses and loess clays	7.1									
Boulder and waethering clays	22.2	7.5						1.0	3.3	
Pleistocens loams and silts	20.0	30.6	99.5		9.2		26.5	6.1	20.7	14.1
Tertiary formations										
Pliocene loams	10.3	34.0		11.6	5.7		9.2	16.8	55.9	45.2
Miocene loams	10.1	13.0	0.5	86.1	29.2	91.7	36.8	58.9	7.0	0.2
Oligocene and Eocene loams and shales	1.2	4.8						2.5	2.9	
Mesozoic and Palaeozoic formations;										
Cretaceous, Jurassic and Trias loams and shales	6.3	1.7		2.3	9.3	2.4	14.1	0.2	2.7	
Permian and Carboniferous loams and shales	8.6	3.0			46.6	5.9	13.0	2.6	0.1	
Undefined formations	4.2	0.2					0.4			
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The influence of natural factors on production costs

This problem was investigated on the basis of the analysis of factors influencing the unit cost of production of cement and brick products. The following features, as essentially connected with the geographical environment, were taken into consideration in the analysis: for cement production, two production phases (the extraction of raw material and clinker burning), and for brick-product production, three phases (extraction of raw material, production of raw bricks, and natural drying).

All natural features influencing the production costs of cement and brick products were classified as constant, that is influencing the cost during a longer period of time, or "variable", resulting from the periodical changes in the weather conditions of the region in which the production plant is located.

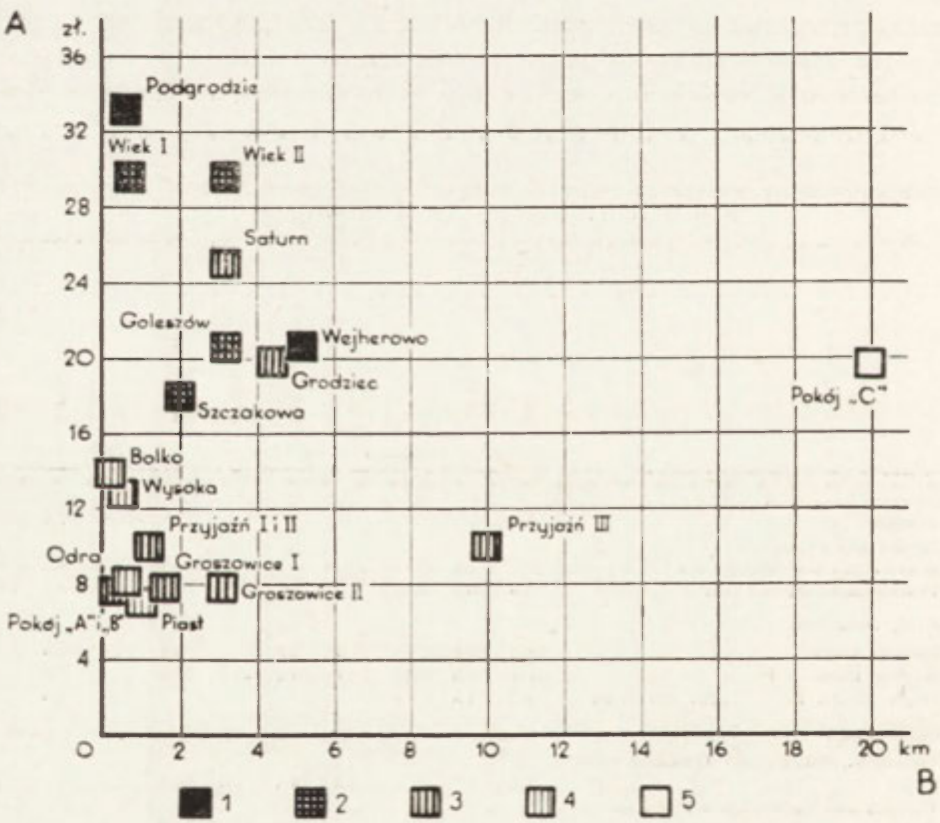

Fig. 1. Dependency of exploitation costs of raw material on the conditions of exploitation and distance between quarries and cement mill

A — Cost of raw materials per unit, B — Distance of raw material site from cement mill. Scale of conditions of exploitation: 1 — very difficult, 2 — difficult, 3 — medium difficult, 4 — good, 5 — very good.

The constant factors, in which the natural conditions of the exploitation of a deposit and its distance to the production centre were included, influence the unit production cost in a decisive manner, which permits the differentiation of defined classes of plants according to the height of the costs. The variable factors, however, cause this height to vary (within a given class) in various periods of time. The characteristic feature of the variable weather factors is that in relation to the geomorphological situation of the deposit and the quality of raw materials they influence the production costs with various degree of delay, reaching even a year (e.g. the influence of precipitation in deep quarries of cement raw materials).

TABLE 3. BRICKWORKS* IN POLAND ACCORDING TO THE COST OF EXTRACTION AND TYPE OF RAW MATERIALS

Type of raw material	Cost of extraction of 1 cubic meter of the raw material in zloties						
	less than 10	10—20	20—30	30—40	40—60	more than 60	Total
	in percentages of the total of brickworks processing a given raw material						
Quaternary formations							
Alluvial	2.4	34.2	31.7	26.8	4.9		100.0
Loesses and loess clays	37.0	44.5	14.8			3.7	100.0
Boulder and waethering clays	6.5	29.0	23.4	18.7	17.7	4.7	100.0
Pleistocene loams and silts	8.9	14.8	24.8	18.8	17.8	14.9	100.0
Tertiary and older formations:							
Pliocene loams	6.2	37.5	23.8	13.8	17.5	1.2	100.0
Older Tertiary loams	1.1	20.2	16.9	16.9	35.9	9.0	100.0
Mesozoic loams and shales	11.1	26.0	22.2	37.0	3.7		100.0
Paleozoic loams and shales	3.4	34.5	44.8	13.8	3.5		100.0

* 500 brickworks with an annual production of over 2 million ceramic units.

The dependence of the height of the unit production cost in phase I (extraction of raw materials) on the constant factors is presented in Figure I (for cement mills) and Table 3 (for brickworks). A very low cost of raw material extraction was noted for the deposits of Turonian marls exploited by the "Pokój" cement mill at Rejowiec, endowed with best-exploitation conditions (the considerable increase in the raw material costs of the "Pokój C" deposits is connected with the great distance of this deposit from the production centre). The cement mills in the Opole centre are run on exceptionally low costs as primarily these plants are exploiting very simple, undisturbed tectonics of deposits. In Table 3 items like the relatively low cost of exploitation of easily accessible and malleable loesses and loess clays with a simple structure of deposits, and the high costs of extraction of older Tertiary loams, often lying in disturbed stratas and under thick layers of younger compositions, are also particularly striking.

The influence of the exploitation of deposits and processing of raw materials on changes in the geographical environment

The investigation of this problem was carried out primarily in the cement industry, and included in particular: (a) changes in the topographical features of the surface, (b) changes in the ground water resources.

Changes in the topographical features of the surface were investigated from the aspects of (a) the speed of the changes occurring, and (b) the forms of transformation of the surface.

It was estimated that since the beginning of their activities cement mills now existing in Poland have destroyed about 600 hectares by the extraction of raw materials. The average speed of the destruction of the surface by individual plants grows with the development of cement production and amounts to about 25 hectares annually for the whole country (Table 4).

TABLE 4. TRANSFORMATION OF THE SURFACE BY THE EXPLOITATION OF BASIC RAW MATERIALS FOR CEMENT PRODUCTION IN POLAND

No	Cement mills	Quarries (desposits)	Year of start of exploitation	Surface exploited in hectares			
				prior to 1958 total	annual average	1956—1958	
						total	annual average
1	"Bolko"	"Bolko"	1901	10.8	0.19	0.6	0.28
2	"Goleszów"	"Górna Leszna"	1951	11.7		2.0	1.03
		"Pod Chełmem"	1958	0.1	0.53	0.1	
		Old quarry	1898	c. 20.0		—	—
3	"Grodziec"	"Rogoźnik"	1949	8.9	0.50	1.7	0.84
		Old quarry	1856	c. 42.0		—	—
4	"Groszowice"	No. 1 ("right")	1872	57.3	0.99	5.1	5.55
		No. 2 ("left")	1872	27.4		6.0	
5	"Odra"	"Odra"	1913	31.6	0.70	3.3	1.64
6	"Piast"	"Piast"	1911	20.5	0.44	2.0	0.98
7	"Podgrodzie"	"Podgrodzie III"	1946	21.3	1.40	3.2	1.58
		Old quarries	1912	c. 45.0		—	—
8	"Pokój"	"A"	1924	14.4		0.5	
		"B"	1954	8.5	1.45	3.1	4.05
		"C" Chełm	1924	26.1		8.1	
9	"Saturn"	"Gawczyce"	1930	59.7	2.13	1.6	0.79
10	"Szczakowa"	"Sadowa Góra"	1955	3.1		1.0	0.49
		"Gródek"	1883	23.9	0.49	—	—
		Old quarries		c. 8.0		—	—
11	"Wejherowo"	"Orle III"	1952	c. 19.0	0.77	3.5	1.77
		Old quarries	1872	c. 47.0		—	—
12	"Wiek"	"Wiek"	1913	26.9	0.60	3.8	1.91
13	"Przyjaźń"	"Rzeczków" and "Wierzbica"	1952	10.0	1.67	1.0	0.52
		"Marylin"	?	5.7		—	—
14	"Wysoka"	"Wysoka"	1885	36.5	0.50	3.8	1.91
15	"Górka"	"Górka"	1912	c. 19.6	0.43	?	?
	Total			605.0	0.69	50.4	25.16

Between 1880 and 1958 Polish cement mills increased the speed of transformation of the surface at least ten times through the exploitation of the raw materials necessary to cement production. It is worth noting, however, that the development of cement production is decisively speedier than the destruction of the surface. Factors checking the degree of destruction are above all (a) the rational economy of the deposit, (b) technological progress (better processing of raw materials and introduction of subsidiary raw materials).

The forms of transformation of the sufrace were investigated upon a division into erosive (concave) and accumulative (heaps, embankments, etc.) .The great majority of quarries of cement raw materials possess deeply-dug exploited areas in flat terrains. These forms contrast greatly with the natural environment and are the most difficult for recultivation. Quarries with exploited areas on slopes, in hilly or mountainous terrains, come second. These forms are easily recultivated, owing to the advantageous flow of waters according to the direction of natural incline. The accumulative forms in the regions of such quarries are small in comparison with forms of the erosive type. In many cases they are put to economic use either by afforestation or for road-building purposes, etc.

To define changes in the ground water resources caused by the industrial activities of cement mills, an attempt was made to designate the theoretical areas drained of precipitation by individual plants, afterwards correlating the extents of these areas with the results of preliminary hydrogeological investigations. In the region of three cement mills, the existence of positive correlations between the size of the theoretical drained areas and the level of ground waters used for industrial purposes was proved. This fact permitted the selection of plants which should be paying a special attention to the danger of lowering the ground water level by drawing water from too large an area.

*

This article contains only an example of the presentation of results achieved within the scope of interrelations investigated, which are in reality very numerous.

The results achieved are important both because of scientific-cognitive reasons and for their practical significance. The most exhaustive possible analysis of the links between the cement and brick industries and the geographical environment was treated as a necessary stage in the detailed work, without which it would have been impossible to work out the full economic-geographic characteristics of the distribution of such branches of industry. The results achieved are also of significance as a contribution to the theory and practice of the distribution of production, as far as defining the localization significance of natural factors is concerned; e.g. the results of the analysis of the influence of the raw material bases on the brick industry constitute a detailed proof of the thesis that assessing whether brick raw materials are ubiquitous or localised raw materials is aimless without previous consideration of such elements as the type of raw material, the range of production and the size of the brickworks analysed. The definition of the production role of various cement and brick raw materials, as the basis for the work of standardizing raw materials, is also of obvious value for economic practice.

The established data concerning the influence of the operation of cement mills and brickworks on changes in the geographical environment are of particular practical value. They are an element on which the elaboration of methods of preventing excessive or superfluous destruction of nature is based, this prevention being not only necessary for aesthetic or health purposes but also because of the need to secure further opportunities for the economic development of individual regions.

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DONBAS AND UPPER SILESIA — A COMPARATIVE ANALYSIS OF THE INDUSTRIAL REGIONS

Bronisław Kortus

The industrial regions of Donbas and Upper Silesia represent important economic centres in Central and Eastern Europe. These regions are basically similar to each other from the point of view of their genesis and economic structure. In many other aspects, however, they are dissimilar. The purpose of our present investigation is to show the important analogies and differences that exist between these two regions. Of no less importance is the selection and application of such a group of comparative elements which also could be applied in the comparisons of other industrial centres in the world.

The method of comparison, which is the basis of our analysis, has since the 19th century been currently known in geography. If traditional methods of comparison were based mainly on qualitative description of comparative facts and phenomena, present development of geography demands the application of the comparative analysis of quantity. The elements chosen for comparison were drawn up into 6 groups of relative subjects: I. The size and productive potentials of the two regions. II. The size and structure of the coal resources — the main bases of the raw materials of the two regions. III. The historical-economic development of both regions. IV. The proportions between different branches of industry. V. The coal industry as a leading branch of industry in both regions. VI. The spatial structure and urbanization of the two regions. This of course does not exhaust all the possibilities of comparison. The 40 comparative standards applied here were conditioned by the accessibility of suitable material.

I. Size and production potentials

It is evident from the table that there exist two fundamental differences between the compared regions. Namely that Donbas is several times larger than Upper Silesia, not only in its area, but in its population and the whole of its production potentials. On the other hand, from the point of view of their significance, the situation is reversed because Upper Silesia has a considerably greater economic significance for Poland than Donbas has for U.S.S.R.

TABLE 1. SOME PARTICULARS ON THE SIZE AND PRODUCTION POTENTIALS OF BOTH THE REGIONS 1960

Specifications	Donbas [1]	Upper Silesia [2]	Donbas / Upper Silesia	Role in %	
				Donbas / USSR	Upper Silesia / Poland
Area (in km²)	about 33000	4800	6.8	0.15	1.5
Population (in 1000 inhabitants)	7000	2614	2.7	3.2	8.8
Industrial employment (in 1000 persons)	1500	681	2.2	6.5	22.7
Coal resources (in billion tons)	240	150	1.6	6.0	99.0
Coal output (in million tons)	188	101	1.9	50.0	97.0
Coke production (in million tons)	about 20	about 6.2	3.2	33.0	50.0
Electric power production (in billion kWh)	about 23	abond 10.0	2.3	8.0	33.0
Production of pig iron (in million tons)	about 10	1.9	5.3	21.0	41.0
Steel production (in million tons)	about 12	3.6	3.3	18.0	54.0
Production of rolled steel (in million tons	about 10	2.9	3.4	20.0	66.0

[1] The so-called "Industrial Donbas" comprises an area in which about 75% of the area and coal resources fall within the administration of the Ukraine (in the districts of Donetsk and Lugansk) and the remaining part to the Russian Federation (in the Rostov district) [1, 10, 13,].

2 In the present study the "Industrial Upper Silesian Region" comprises the central part of the Katowice voivodship, the urban *powiats* of Będzin, Bytom, Chorzów, Czeladź, Dąbrowa Górnicza, Gliwice, Katowice, Mysłowice, Ruda Śląska, Rybnik, Siemianowice Śl., Sosnowiec, Świętochłowice, Tychy, Zabrze, and the rural *powiats* of Będzin, Gliwice, Rybnik, Tarnowskie Góry, Tychy and Wodzisław Śl., as well as the western area of the Kraków voivodship namely the *powiats* of Chrzanów, Oświęcim and the town Jaworzno.

II. The size and structure of the coal resources

As a result of the most recent post-war geological investigations new boundaries and resources in the Donets Basin, known as the "New Donbas", have been determined, comprising an area of 40 thousand km² and with resources of about 240 billion tons[1] [1, 13]. The resources of the Upper Silesian Basin, which has an area of about 4240 km², contain about 80 billion tons for the thickness of beds above 0.8 m and to the depth of 1000 m [7]. However, taking similar criteria as in the Donbas into consideration, they contain about 150 billion tons [3]. Because of the thickness of its coal deposits Donbas is a basin with thin coal-beds (average 0.9 m), opposite to Upper Silesia,

[1] In the years between both World Wars the „Old Donbas" was known, comprising an area of 23 thousand km² and with resources amounting to about 90 billion tons.

where for example in 1959 the average thickness of the exploited deposits was 2.8 m [12]. Apart from this, the coal-beds in the Donets Basin are strongly tectonically disturbed [13], and this on the whole creates considerably more difficult conditions for its mining than in Upper Silesia. In the analysis of the coal fields, an important element is the "index of coal content" or the percentage rate of the deposits suitable for exploitation in relation to the total thickness of the productive carbon-beds, characterising the degree of concentration of coal-beds. In the Upper Silesian Region this index is three times higher than it is in the Donbas (Table 2)[2].

TABLE 2. SOME OF THE PARTICULARS CONCERNING THE DONBAS AND UPPER SILESIA COAL BASINS

Specifications	Donets Basin	Upper Silesia Basin
The area of coal field (in km^2)	c. 40 000	4 240
Geological coal resources (to a depth of 1800 m for coal beds over 0.3 m thick) (in billion tons)	c. 240	c. 150
Mean thickness of beds suitable for exploitation (above 0.5 m)	0.9 m	above 2 m
Index of coal content[1] (vertical concentration of resources)	0.7—0.8%	2.2—2.5%
Resources on one km^2 of the coal field horizontal concentration of resources (in million tons)	c. 6	c. 35
Calorific value of coal (in cal. kg.)	7 100—8 400	4 800—7 800
The qualitative structure of resources:		
anthracite	30%	—
coking coal	28%	14%
meager coal	14%	—
gas-flame coal (energetic coal)	28%	86%

[1] The percentage of coal-beds in relation to total thickness of the productive carbon.

This "index of coal content" is lower in the Donets Basin and this in its turn bears upon the low horizontal concentration of the coal resources. For each km^2 there are about 6 million tons of coal resources $\left(\frac{240 \text{ billion tons}}{40{,}000 \text{ km}^2}\right)$, whereas in Upper Silesia about 35 million tons $\left(\frac{150 \text{ billion tons}}{4240 \text{ km}^2}\right)$[3]. This fact of the greater dispersion of the coal resources, not only in the vertical direction but also in the horizontal direction in the Donbas affects in its turn the spatial structure of the whole region and also the localization of the mines, the industry,

[2] For comparative reasons the value of „index of coal content" of the Kuznetsk Basin was 1.8 [2] and for the Ruhr Basin 2.2-3.5 [2,6].

[3] For the Ruhr Basin the index shows about 20 million tons $\left(\frac{120 \text{ billion tons}}{6200 \text{ km}^2}\right)$ [6].

population, settlements etc. Indeed the above mentioned quantitative indices for the Donets Basin are less profitable but the qualitative ones much higher than those of the Upper Silesia Basin (Table 2). Apart from the higher calorific value of the Donets coal there is a considerable amount of high grade anthracite (30%), coking coal (28%), and meager coal (14%). Therefore a much larger diversity occurs in the Donbas as opposed to Upper Silesia and as a result coal in the Donbas creates many more complete possibilities for its advantageous economic management.

III. Historical Development

The historical development of the Donbas Region and that of the Upper Silesian Region are quite varied. In the Table 3 several facts in the economic history of both these two regions are referred to, which, in a certain sense, influenced the degree and rate of their economic development.

TABLE 3. SOME PARTICULARS CONCERNING THE HISTORICAL-ECONOMIC DEVELOPMENT

Specifications	Upper Silesia	Donbas	Difference in years	Further details	
				Upper Silesia	Donbas
The opening of the first coal mine	1751	1795	44	in Ruda Śl.	in Lisichansk
The first steam engine used	1788	1795	7	in lead mine Tarnowskie Góry	in the arms factory in Lugansk
The first rail-road	1845/46	1863	18	(Wrocław) Gliwice-Mysłowice	rail-road section 67 km (Shakhty-Aksay on the Don)
The application of coke in metallurgy	1796	1872	76	in the Gliwice iron works	in the Yuzovka Donetsk ironworks
The liberation of peasants	1809	1861	52		

TABLE 4. THE DEVELOPMENT OF COAL PRODUCTION IN THE DONETS BASIN AND IN THE UPPER SILESIAN BASIN (THOUSAND TONS)

Years	Upper Silesia [8, 10]	Donbas [2, 10, 11]	Years	Upper Silesia [8, 10]	Donbas [2, 10, 11]
1790	10	2	1920	38,561	4,524
1800	43.4	2.4	1929	68,232	30,980
1810	97.0	2.5	1933	42,996	51,060
1820	163.3	4.1	1940	72,128	85,510
1840	656.2	14.0	1945	24,620	36,934
1860	2,825	98	1950	74,300	89,680
1880	11,600	1,414	1955	90,586	135,330
1900	30,105	11,003	1960	101,300	188,200
1913	52,591	25.288			

The growth of Upper Silesia took place much earlier — in the second half of the 18th century, mainly as a fortunate result of the mercantile politics of Prussia. Within the boundaries of that country the greater part of this coal region was to be found. Apart from this, capitalism developed considerably earlier in this part of Europe than in Russia. The beginning of the development of the Donbas Region commenced only in the first half of the 19th century, its real development, however, took place after the abolition of the overlords, that is to say, after the formal liquidation of feudalism in 1861. How far Upper Silesia was in advance of the Donbas is illustrated by the fact that

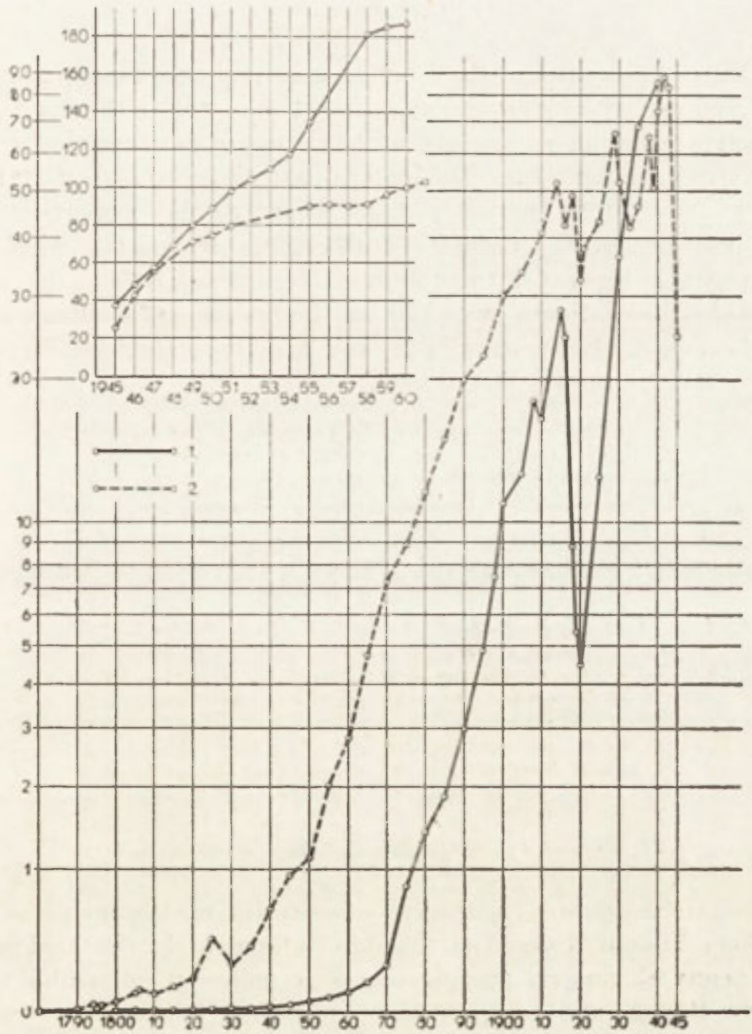

Fig. 1. Coal output in the Donbas and Upper Silesia (in million tons)
1 — Donbas, 2 — Upper Silesia

in the Upper Silesian Region, during the period 1861-1917, about one billion tons [8] of coal were produced and in the Donbas Region during the same period scarcely 411 million tons [2]. On the other hand, the Donbas Region after the October Revolution developed at a considerably faster rate. In 1932 it had already for the first time outdistanced Upper Silesia in regard to the coal output (Table 4 and Fig. 1). Today it is rebuilt after almost complete destruction during World War II. The Donbas Region, as regards the whole of its economic potentials, exceeds several times Upper Silesia.

IV. Industrial structure

The industrial potential of the Donbas is several times larger than that of Upper Silesia, as can be seen in Table 1. In Upper Silesia the degree of industrialization is rather higher assessed in the figures of those engaged in industry relative to 1000 inhabitants. The appropriate index shows that in Upper Silesia it is 260 and in Donbas 214. In regard to the proportions between different branches of the industry both regions are on the whole similar. Both represent the typical coal-metallurgical complexes. In both the conductive element is the coal industry, on which all the branches of industry are based, such as the power plants, metallurgy and machine industries, chemical and building materials industry and others.

TABLE 5. THE PROPORTIONS BETWEEN DIFFERENT BRANCHES OF INDUSTRY IN THE UPPER SILESIAN REGION IN %% OF EMPLOYMENT, 1960

Branches of industry	%
Industry as a whole	100.0
Production of electric and thermic energy	3.9
Coal industry	42.0
Ferrous metallurgy	9.8
Non-ferrous metallurgy	3.0
Machine building and metal industry	14.9
Chemical industry including chemistry of coke	10.3
Mineral industry	5.5
Timber and paper industry	1.7
Textile industry	2.6
Leather and shoe industry	1.8
Food-processing	3.4
Others	1.1

I am able to show the proportions between different branches of industry of the Upper Silesian Industrial Region. Unfortunately the analogical data for the Donets Region are missing and this makes it impossible to analize the Donets Region and compare these problems.

The coal industry therefore is the most important branch of the Upper Silesian Industry. In it were engaged in 1960 about 300 thousand persons that is to say about 42% of all those engaged in industry in this region. On the other hand, the coal industry in the Donbas employs over 500 thousand persons and this represents about 1/3 of all those engaged in industry [11]. As well as this, certain differences exist in the proportions between different branches of industry in both regions, revealing that the part played by the mining and foundring of non-iron metals in Upper Silesia is larger. Any considerable mines of this kind are lacking in the Donbas. On the other hand, the role of the chemical industry is greater in the Donbas, where there are bases of raw materials in the form of a suitable quality of coal as well as salt.

V. The coal industry

The coal industry in the Donbas Region was represented in 1957 by 530 mines while in Upper Silesia there were 74 such mines. In regard to their size however, a considerable difference arises in the two regions. Namely, the Donbas is a region of small mines, the average yearly output barely reached 340 thousand tons, when the same index for the Upper Silesian mines was 1240 thousand tons[4].

Since the October Revolution there has been a considerable reconstruction of the coal industry in the Donbas, including the concentration of its output.

TABLE 6. THE COAL INDUSTRY IN THE DONBAS REGION AND IN THE UPPER SILESIAN REGION

Specifications	Donbas Region [2,10,11]		Upper Silesian Region [10,12]	
Number of mines (1957)	530		74	
Coal output in million tons (1957)	180		91	
Outpury of one colliery in thousand tons	340		1240	
Structure of mines according to their size (1955)	number of mines	output %	number of mines	output %
Mines with year output up to 100 thousand tons	135	6.5	—	—
100— 300	269	43.0	—	—
300— 600	75	26.7	10	5.2
600—1 000	33	23.8	17	15.5
1000—2 000	—	—	40	61.8
over 2 000	—	—	7	17.5
Total	512	100.0	74	100.0
Productivity in kg for one working shift	1260		1 480	
Rate of labour costs in the structure of coal output costs	about 67%		about 40%	

[4] In the Ruhr Basin where in 1953 there were 140 mines with an output of 120 million tons, this index for one mine was 860 thousand tons [6].

In 1913 there were about 1200 active mines in the Donets Basin, with an output of 25.3 million tons, which for one mine can be assessed at 21 thousand tons. On the other hand, in 1940, the number of mines diminished to 314 and the average output of one mine arose to 230 thousand tons. A similar process of the concentration of coal production took place in Upper Silesia and in the same way the yearly output index for one mine in 1850 was 15.4 thousand tons, in 1911 640 thousand tons and in 1938 800 thousand tons [8].

The considerable differences in the structure of the mines, as is evident from Table 6, are of course the result of varied geological conditions of both these basins, especially for the noticeably lower "index of coal content" in the Donets Basin. Moreover, as a result of the less favourable geological conditions, the productivity of the Donbas mines are lower in comparison to Upper Silesia. Furthermore, the considerably more difficult working conditions are reflected in the very high rate of labour cost in the cost of the coal output as a whole.

VI. The spatial structure

The basic differences that exist between the Donbas and Upper Silesian Regions, apart from their size and varied industrial potentials, occur however in their spatial structure, in the degree of concentration of the population, settlements, industry etc. For the documentation of these differences, the following table shows some of the economic elements in both regions in relation to their areas (Table 7).

TABLE 7. SOME OF THE ELEMENTS OF SPATIAL STRUCTURE AND URBANIZATION (1960)

Specifications	Upper Silesian Region	Donbas Region	Upper Silesia/Donbas
Population density (per km^2)	545	212	2.6
Industrial employment (per km^2)	142	46	3.1
Coal output per 100 km^2 (thousand tons)	1 554	570	2.7
Density of rail network (per 100 km^2)	about 26	about 9	2.9
Urban population (in thousand)	2165	about 6 000	—
Percent of urban population in relation to total population	83	84	—
Urban population (per km^2)	450	180	2.5
Number of towns	40	63	—
Number of settlements of urban type	40	260	--

In the light of the above table, Upper Silesia is proved to have an almost three times larger concentration of population, industry and railway network. A similar difference occurs in the concentration of towns and urban population in comparison to the same degree of urbanization in both regions. The urban agglomeration of Upper Silesia comprises 40 towns and 40 settlements of an urban type with over 2 million urban inhabitants. On the other hand, in an almost 7 times greater area of the Donbas there are 63 towns and 260 settlements of an urban type with 6 million urban inhabitants[5].

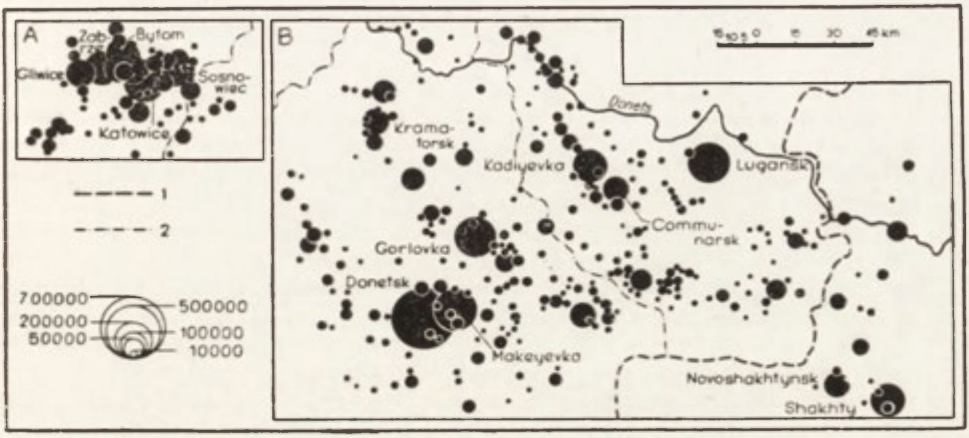

Fig. 2. Industrial regions of Donbas and Upper Silesia
A — Upper Silesia, B — Donbas, 1 — Boundaries of the republics, 2 — Boundaries of administrative units of I order (voivodship in Poland, oblast in U.S.S.R.)

Donbas is therefore a region from every point of view spatially dispersed, whereas in Upper Silesia the degree of concentration is particularly high. In this regard, Upper Silesia resembles the coal regions of Western Europe, especially the Ruhr and the Saar, even revealing a greater degree of concentration than most of the English mining regions. These differences in the spatial structure of both the compared regions are mainly caused by the dissimilar distribution of the coal industry. Thus the coal output of the Donbas is dispersed over several separate areas such as Donetsk-Makyevka, Gorlovka-Yenakiyevo, Kadiyevka, Lisichansk, Shakhtiorsk-Krasnyj Luch, Shakhty and others. On the other hand, in Upper Silesia 60 mines and 76% of the coal output are concentrated in the central part of this region between Gliwice, Katowice and Jaworzno. Such a dissimilar arrangement of the coal industries is in its turn the result of the varied geological conditions existing in both the basins. In Upper Silesia the vertical as well as the horizontal concentration

[5] Even greater differences occur in the actual distribution of towns in the two regions. The agglomeration in Upper Silesia basically represents one large and coherent urban area consisting of the 20 largest towns and settlements (from Gliwice and Łabędy in the West to Jaworzno and Strzemieszyce in the East) and including the population of 1670 thousand, which is 80% of the total urban population. The remaining 20% of the urban population devolves on the smaller, scattered towns around the central area. In direct opposition to this urban agglomeration, Donbas is noticeably scattered, dispersing itself into 20 separate centres.

of the coal resources, higher than in the Donbas, have determined the appropriate distribution of their coal industry as well as the dissimilar spatial structure of all the existing economic elements in both regions.

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SOME SPATIAL PROBLEMS OF THE DEVELOPMENT OF THE CEMENT INDUSTRY IN POLAND 1946—1980

ANTONI KUKLIŃSKI

The cement industry is one of the most rapidly developing branches of industry in Poland (cement production increased from 1.4 million tons in 1946 to 7.5 million tons in 1962, the 1980 production has been estimated at 29 million tons in the highest projection of the perspective plan).

Among the important factors influencing the efficiency of the cement industry are the spatial conditions, and particularly such aspects as the relationship to the geographical environment (supply of raw materials) and the influence of distance on the economics of production and distribution of cement. The second aspect is analyzed in this paper.

Like the iron and steel industry, the cement industry is one of the so-called transport intensive industries. In 1960, 11.6 million tons of raw materials and finished goods were dispatched to or from factories by external transport, 0.65 million tons locally between various factories and 8.3 million tons inside the factory complexes.

The current system of so-called *franco* prices now in force in Poland signifies that in the prices of inputs are not reflected the spatial differences in transportation costs. Consequently the advantages of having a cement mill located in a supply region do not diminish the production costs of an individual mill. In order to establish the level of transportation costs reflecting in each case the advantages and disadvantages in the spatial relations of inputs and outputs the following balance has been computed (Table 1).

The balance presented in this table fixes the share of the costs of transportation and of the processing costs in the total costs of cement production. The comparison between the costs of transportation in various cement mills shows that the differences are slight. This is largely due to the fact that Poland's territory is relatively small and the spatial balance of supplies and sales (foreign trade excluded) is made in an area of a few hundred km^2.

In spite of this the development programmes for the cement industry must also consider the problem of the optimal distribution of outputs. The material presented in this paper includes the results of an attempt made for the first time in Poland to apply the method of linear programming to the economic-geographical analysis. It aims at a verification of hypothetical locations included in the plan for the development of the national economy in 1961-1980.

Minimal costs of cement in the place of demand, that is jointly the processing costs and the costs of transportation, have been accepted as the criterion of the optimal distribution pattern for the cement industry. This is not, however, a problem of the minimal costs for each individual mill, but of find-

Fig. 1. Regions of the cement industry in Poland 1946–1980

Areas of deposits: 1 — limestone, 2 — marl, 3 — chalk, 4 — chalk marl, 5 — dolomites, 6 — chalk marl and dolomites, 7 — gypsum and anhydrites, 8 — cement mills in operation in 1960, 9 — planned cement mills, construction 1960–1980 ing a solution that will reduce to a minimum the joint costs in all the cemen-mills of the country as a whole, or in a given region. The method of the sot -called "open transport solution" has been accepted which in this place means that the volume of supplies of cement exceeds that of demand by a definite quantum of the demand from a "fictitious recipient". It has been assumed that: (1) there are 34 production points with a joint output of 29 million tons (1980), while the total home demand amounts to 25 million tons, the difference being the demand by a "fictitious recipient"; (2) the spatial structure of cement consumption included 17 points, voivodship towns. Furthermore, some simplified assumptions have also been introduced as to the future trends in the formation of processing costs, types of cement produced and transportation costs.

TABLE 1. BALANCE OF TRANSPORT COSTS IN THE POLISH CEMENT INDUSTRY IN 1960[1]

Commodity	Costs of transportation	
	in million *zloties*	in percentages
Basic raw materials	11.6	—
Blast furnace slag	35.5	—
Clinker	31.4	—
Gypsum	9.6	—
Coal	40.0	—
Cost of transportation of inputs	128.1	5.0
Costs of transportation of outputs	351.5	13.8
Total costs of transportation	479.6	18.8
Total processing costs	2067.0	81.2
Total processing and transportation costs	2546.6	100.0

[1] Only for commodities sent by long distance transport

The first conclusions of this analysis is that the processing costs are most important. As the transportation costs are rather slight in comparison with the total costs of cement production, it can be accepted that Poland's territory is in fact one single region as far as the balance of production and sale of cement is concerned. Small mills with high production costs predominate among mills producing cement in non-optimal conditions for supplies to the "fictitious recipient". There was a single case only in the northern region where owing to the low transportation costs the mill belonged to the optimal pattern despite high production costs. This, however, is an exception which proves the general rule. The analysis also reveals that in the southwestern region relatively small differences in the production costs shifted 10 cement mills into the non-optimal pattern.

The analysis also leads us to formulate a question whether or not there is any point in closing some obsolete mills with high production costs in the vicinity of mills with low production costs.

The second basic conclusion is the low economic efficiency of the spatial separation of the two phases of the technology process, the production and the grinding of clinker. It appears that mills grinding clinker brought in from outside belong to the non-optimal pattern, and thus the concept of building new grinding stations of this type has been abandoned correctly in planning the development of the cement industry. It also seems that in Polish conditions two types of cement mills should be envisaged: (1) a cement mill with a full production cycle, and (2) a distributing station localized in cement-marketing centres at a distance from production centres.

The main advantage of the presented analysis is the determination of weak links in a planned location pattern. The results of our analysis are of course still provisional and introductory. Similar computations should be made for further variants in the localization of new mills, allocation of various types of cement and in the spatial consumption patterns.

Large-capacity mathematical computers would also be of great help in achieving a much more complicated and, at the same time, more realistic pattern. Detailed studies of raw materials deposits would also answer the question whether the resources are sufficient to plan production for a long period. In this analysis we have assumed that all planned mills will produce cement at low costs which seems to be incorrect in view of the difficulties concerning raw materials in one or two places chosen for the location of new plants.

Thus it seems necessary to work out a new and more precise variant of the optimization analysis. A better knowledge of the production and transportation costs is of particularly great significance as the correct solution of the model is decisively conditioned upon a correct selection of basic data. It is quite obvious that wrong assumptions as to the level and structure of costs will affect the final result of the analysis. The high standard of these studies is as dependent on the standard of the scientific methods applied as it is on the knowledge of the future structure of the phenomena analyzed.

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CHANGES IN THE SPATIAL STRUCTURE OF INDUSTRY IN UPPER SILESIA IN 1946—1960

ANTONI WRZOSEK

The purpose of this article is to characterize changes in the spatial structure of industry in 1946-1960 in Upper Silesia (Katowice voivodship), which is not only the largest Polish industrial region, but also one of the largest in Europe, 734,000 people being employed in 1960 in industries spread over an area of 9,500 km² (3,665 square miles).

The Upper Silesia industrial district developed thanks to the large coal deposits totalling c. 70 billion tons, and to relatively easy conditions for their exploitation. Besides coal there are also large deposits of zinc and lead and much smaller deposits of iron ores. At the time when the presence of coal induced the development of industry that is in the 19th and early 20th century, a powerful industrial complex developed around the coal deposits. It was mainly concerned with the output of raw materials, particularly coal, but also zinc, lead, and iron ores, as well as with metallurgical production of iron, zinc and lead, finally extending even to the production of electrical energy in coal-fuelled power stations. For a long time Upper Silesia lagged behind the large West-European basins, where not only extracting of raw materials but also manufacturing industries developed quite early. This resulted from the peripheral situation of Upper Silesia within the German state (by which the greater part of it was administered up to the First World War), a condition unfavourable for the development of transport. Nor did the industrial structure change in the inter-war Polish state, which was economically weak and dominated by foreign capital, and to which only a part of the Upper Silesian region belonged. Changes occurred only after the Second World War, when the whole region was united within the frontiers of Poland.

Changes in the proportions between different branches of industry in Upper Silesia can be investigated by analysing employment, as unfortunately there are no data which illustrate in detail the changes in the value of industrial output. It can only be stated in a general way that in 1950-1960 the total value of industrial products in Katowice voivodship increased by 116.7%, that is it more than doubled. The post-war evolution will be analysed upon the figures of 1946, the first post-war year of normal work in industry, and of 1960, which gives a picture relatively very close to the present situation. It is also worth noting that in 1946-1960 the per capita productivity increased greatly, the average for the whole industry rising approximately threefold. But the increase was much less in the extraction industries than in manufacturing, particularly machine-building and chemical industries, as in 1950-1960 the total per capita production in the machine-building industry increased 4.4 times, and in the chemical industry 3.3 times. Thus, the same number of workers did not produce equal values in 1946 and in 1960.

TABLE 1. PROPORTION OF VARIOUS BRANCHES OF INDUSTRY BY NUMBER OF INDUSTRIAL WORKERS IN KATOWICE VOIVODSHIP IN 1946 AND 1960

Branch of industry	1946		1960	
	number	%	number	%
Total	402,781	100.0	776,885	100.0
Production of electric and thermal power	8,268	2.1	14,038	1.8
Fuel industry and coke chemicals	173,459	43.1	297,959	38.3
Ferrous metallurgy	64,212	15.9	91,875	11.8
Non-ferrous metallurgy	12,023	3.0	19,929	2.6
Machine-building and metal structures	55,705	13.8	141,246	18.2
Chemical industry	12,395	3.1	22,032	2.8
Rubber industry	149	0.1	1,101	0.1
Mineral and building-material industries	15,961	3.9	31,596	4.1
Glass and pottery industries	3,495	0.9	6,673	0.9
Timber industry	6,916	1.7	17,233	2.2
Paper industry	6,124	1.5	8,192	1.1
Textile industry	25,799	6.4	57,623	7.4
Clothing industry	2,106	0.5	13,931	1.8
Leather and footwear industry	1,397	0.4	9,016	1.2
Food industry	9,413	2.3	34,525	4.4
Other branches of industry	5,163	1.3	9,916	1.3

As the damage to industry in the Katowice voivodship was relatively insignificant, it can be accepted that the proportions between different branches of industry in 1946 was almost the same as in the pre-war period. Table 1 shows the structure of industry, as reflected by percentages of workers in the various branches in 1946 and 1960. It appears that in 1946 64% of all industrial workers were employed in coal and ore production, metallurgical production, and power production, which confirms that the industry was predominantly of an extractional character. The machine-building and metal industries employed slightly more than 13%, the mineral and building-material industries even less than 4%, the textile industry slightly over 6%, and food production over 2%. These branches, however, were to a great extent localized outside the main industrial complex of the coal basin, in the southern and north-eastern part of the voivodship.

The spatial structure of employment in industry is shown on the maps. The first two present this aspect for the years 1946 and 1960 as to area, the following two in percentages of the population, the last two show changes which occurred between 1946 and 1960 expressed as numbers of industrial workers in relation to the area and population. The units in all maps are *powiats* and towns of *powiat* status.

The analysis of employment in industry in 1946 expressed in relation to the area (Fig. 1) shows great contrasts. Towns situated in the centre of the region employed from 100 to 1000 industrial workers per km², and the town of Swiętochlowice even more. Similarly the centre of the textile and metal

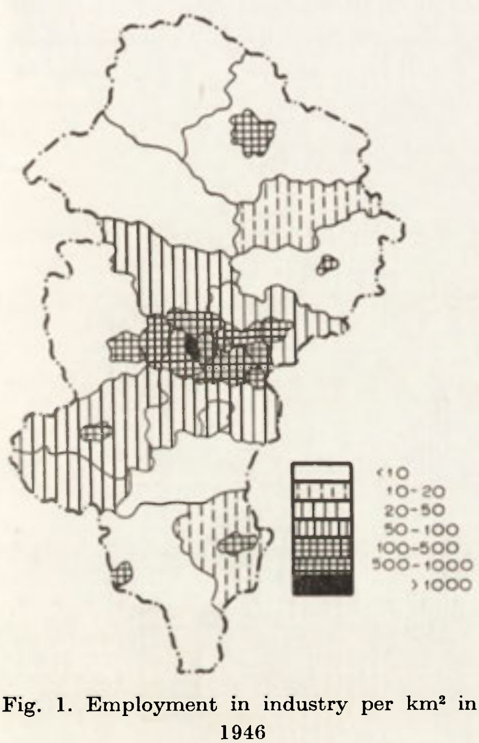

Fig. 1. Employment in industry per km² in 1946

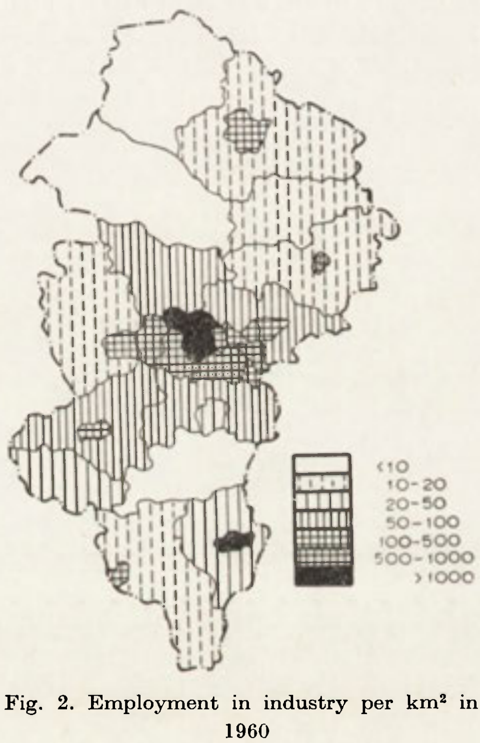

Fig. 2. Employment in industry per km² in 1960

industries, Bielsko-Biała, situated in the southern part of the voivodship, employed more than 500 workers per km², whereas other towns with independent local authorities, dispersed throughout the whole territory, employed from 100 to 300. Rural *powiats* show the reversed situation. In the middle of the voivodship the number of industrial workers per km² varied between 20 and 50, but in the south, and even more in the north, it amounted to less than 20 or even as few as 10 per km². With an average for the voivodship of 42 workers per km² in 1946 the *powiat* of Kłobuck employed only 0.5, the *powiat* Pszczyna 0.8 and the *powiat* of Lubliniec 2.5.

As employment in industry in relation to area is greatly influenced by the distribution of settlements and population, the index relating to population is of greater value to illustrate the intensification of the process of industrialization (Fig. 3). In the most industrialized towns of Bielsko-Biała, Ruda Śląska, and Katowice, industrial employment was more than 400 industrial workers, whereas in other towns, situated in the middle of the region, 200-400 and in other large towns 100-200 per 1000 inhabitants. In the four rural *powiats* also the number of industrial workers exceeded 100, but the *powiat* of Kłobuck had only 6, Pszczyna 8, and Lubliniec 42 industrial workers per 1000 inhabitants. The differences were smaller than in relation to area, but the domination of the highly industrialized coal basin and of the Bielsko-Biała region over other parts of the voivodship is clearly visible. Shortage of space does not permit the detailed analysis of Figs. 2 and 4,

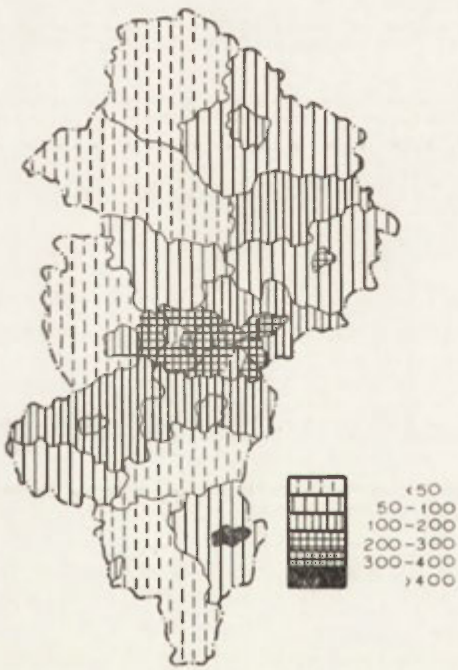

Fig. 3. Employment in industry per 1000 inhabitants in 1946

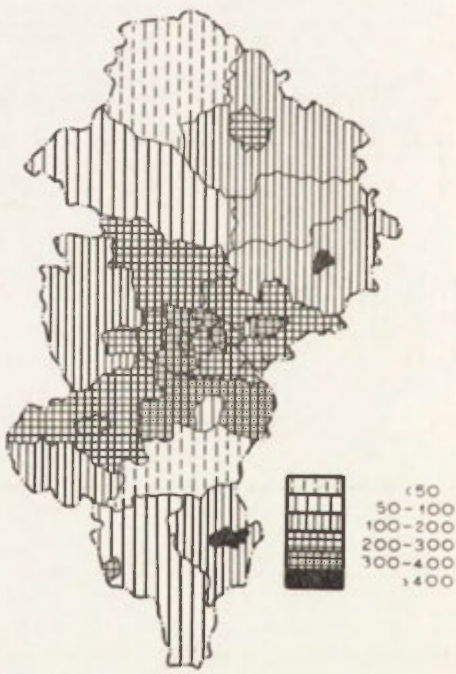

Fig. 4. Employment in industry per 1000 inhabitants in 1960

which show the same relationships for the year 1960. Let us concentrate on Figs. 5 and 6 which also present changes in 1946-1960. Fig. 5 shows that with the sole exception of the town of Będzin where employment in industry in relation to area dropped by 6%, everywhere else there was an increase. It was smallest in the towns situated in the middle of the district (with the exception of Gliwice), varying between 17% and 79%. The greatest increase affected the little-industrialized *powiats*, such as Kłobuck, Pszczyna, and Gliwice, and the towns of Cieszyn and Zawiercie, where the increase exceeded 200%, amounting in Pszczyna *powiat* to as much as 280%. This proves that between 1946-1960 the distribution of industry became more even, which is a favourable situation. In fact industrialisation is more even since employment is related to the locality in which the factories are situated and not to the places of residence.

The correctness of this assumption is confirmed by analysis of Fig. 6, which presents changes in industrial employment in relation to population. It appears that in five towns of the central part of the region the number of industrial workers dropped in comparison with the whole population. The town of Tychy which is also included in them was redeveloped on a large scale as

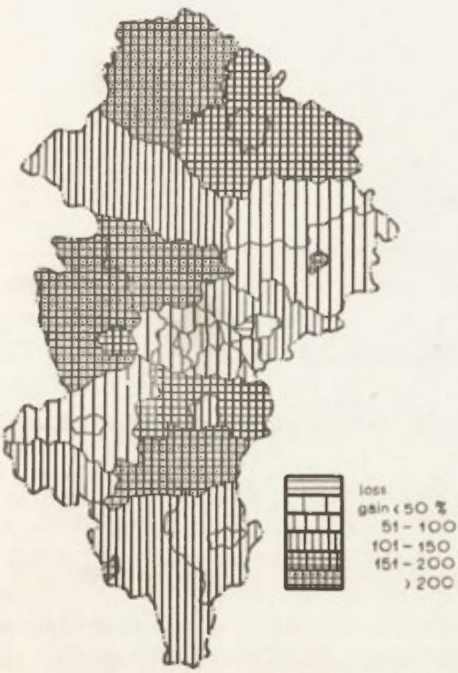

Fig. 5. Changes in industrial employment per km² in 1946—1960

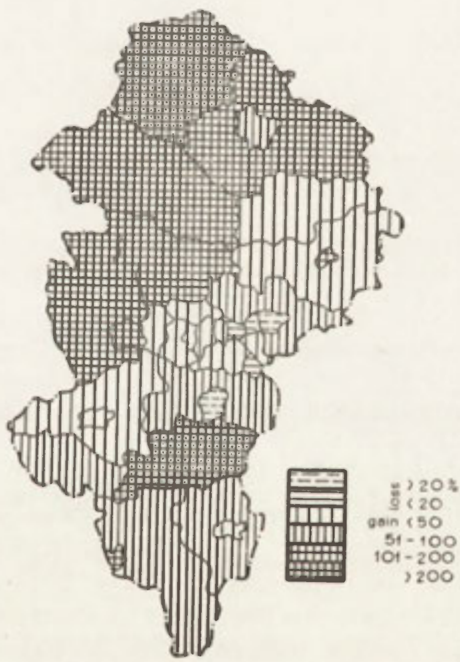

Fig. 6. Changes in industrial employment per 1000 inhabitants in 1946—1960

a residential centre without any large factories, its population commuting to neighbouring towns. All other towns and neighbouring *powiats*, already strongly industrialized, show an increase of industrial workers in relation to the number of inhabitants from 1% (Chorzów) to 50% (*powiat* of Będzin). This increase is much greater in *powiats* which were poorly industrialized, and exceeds 200% in the least industrialized *powiats* of Kłobuck (283%) and Pszczyna (225%). Thus, despite the existing domination of the industrial complex of the coal basin, a relative deconcentration of industry occurred systematically in the Katowice voivodship, whereas the biggest development took place in the hitherto neglected territories.

TABLE 2. PERCENTAGE OF EMPLOYMENT IN KATOWICE VOIVODSHIP IN RELATION TO TOTAL EMPLOYMENT IN POLAND IN VARIOUS BRANCHES OF INDUSTRY IN 1946, 1956 AND 1960

Branch of industry	1946	1956	1960
Total	32.4	26.5	23.5
Production of electric and thermal power	24.5	32.1	21.2
Fuel industry and coke chemicals	74.5	77.9	78.9
Ferrous metallurgy	84.5	73.6	69.8
Non-ferrous metallurgy	90.7	56.4	49.8
Machine-building and metal structures	24.9	19.6	16.7
Chemical industry	37.4	15.5	13.9
Rubber industry	2.4	4.1	3.9
Mineral and building-material industries	24.7	16.6	16.4
Glass and pottery industries	14.4	15.3	11.2
Timber industry	10.3	8.7	8.6
Paper industry	25.7	21.4	18.0
Textile industry	12.9	16.0	14.9
Clothing industry	6.1	6.3	8.6
Leather and footwear industry	6.8	5.5	6.8
Food industry	6.5	8.6	8.5
Other branches of industry	16.2	14.2	13.5

Besides these changes in the spatial structure of industry there were also some characteristic changes in the pattern. As is apparent from Table 1, in the period under analysis the percentage of workers employed in the fuel industry, metallurgy and power production in the Katowice voivodship dropped from 64% to 54%, whereas the respective share of manufacturing industries, particularly the machine-building and metal industries (18.2%), the food industry (4.4%), the timber, textile, clothing, and building-material industries increased. Upper Silesia was then gradually changing from an industrial region producing mostly raw materials to a district with a wide range of production.

Let us add a few words about the localization of some of the more important branches of industry. Coal production is situated mainly around the towns in the central part of the voivodship and in the *powiats* of Rybnik, Tychy, Będzin and Wodzisław. The most important centres of iron metallurgy are the towns of Chorzów, Katowice, Częstochowa, Ruda Śląska, and Dąbrowa Górnicza, whereas the *powiat* of Częstochowa plays an essential role in the excavation of iron ores. The extraction and metallurgical processing of zinc and lead are concentrated in Katowice and Bytom, and in the Tarnowskie Góry *powiat*. In the machine-building industry the most important role is played by the towns of Katowice, Bielsko, Gliwice, Sosnowiec, and Zabrze, and in the chemical industry by Chorzów, Gliwice, and the Tarnowskie Góry *powiat*. Finally the textile industry has its largest centre in Bielsko-Biała, Częstochowa, Sosnowiec, and Zawiercie; other branches of industry have not created any specific centres.

Finally the role played by Upper Silesia in the industry of the whole country, and the evolution of this role during the period under consideration, are worth noting. The Katowice voivodship occupies 3% of the surface of Poland; in 1946 its population comprised 10% and in 1960 11% of the total. In 1946 it was the single large industrial district in Poland and its population comprised almost 1/3 (to be precise 32.4%) of all industrial workers. In the meantime all Poland has undergone a process of industrialization. This was relatively weakest in the Katowice voivodship, so that the percentage of those employed in industry in this area dropped to 23.5%. In relation to the Polish industrial population, as a whole, only the proportion of people working in coal mining, light industry and the food industry increased, dropping very greatly in the chemical, machine-building, metallurgical, and building-material industries. The decrease of this proportion in the paper, timber, and glass and ceramics industries is also quite evident. Table 2 presents data which show that in one branch only — the rubber industry — the percentage of employment in the Katowice voivodship is approximately equal to its proportion of the total area of Poland. These proportions for the timber, clothing, leather, and food industries are slightly less than their proportions in the total population, that in the glass and ceramics industry is almost identical with the population index. The figures for all other branches of industry still continue to exceed the proportion of the population in the voivodship to Poland's total, sometimes very considerably, e.g. in the fuel industry.

In 1960 with a density of population three and a half times greater than the average for Poland, the Katowice voivodship employed eight times as many industrial workers per km^2 and twice as many per 1000 inhabitants than the respective national averages. There are still, however, *powiats* with an employment per 1000 inhabitants lower than the national average, such as Kłobuck (25% of the average), Pszczyna (28%), the town of Tychy (50%), Cieszyn (80%), and Lubliniec (84%). Generally speaking despite its relatively diminished role in Polish industry, the Katowice voivodship still remains Poland's largest and most important industrial region.

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SPATIAL MODELS IN THE REGIONAL PLANNING OF TRANSPORT

Ryszard Domański

For the purpose of this article a transport-network model means an ordered system of transport lines. This model can be expressed in simple or mathematical language. In the second case it is called a mathematical model, and can be presented either by geometrical figures or as a set of equations.

The observation of transport systems arising in the natural way induced the idea of the mathematical presentation. These systems are sometimes amazingly regular; usually, however, they comprise many sections, dead, excessively developed, or underdeveloped, as they are one-sided adapted to transport needs which grow unevenly and are often transitional. Thus the natural systems may be non-coordinated and uneconomical. Attempts to arrange them, initiated in ancient times in urban planning projects, have led to the elaboration of theoretical systems [1] at first geometrical, then in the form of a set of equations.

Two geometrical systems of transport network are known: the triangular, developed from the hexagonal system, and the rectangular. They reach their extremes in the form of an equilateral triangle and a square. This signifies that, assuming some simplified conditions, the transport systems are most economical in these forms, their joint cost (i.e. that of building of transport lines and that of transportation) being the lowest.

Both geometrical systems are characterized by a fairly high degree of conformity with actual transport systems (particularly in agricultural or agricultural-industrial areas). But the actual systems were not usually correctly and regularly shaped from the very beginning. Correct and regular systems stabilize only during the historical development of transport, by means of selection. Railways and roads correctly located endure the test of time and preserve their directions despite changes in forms of transport. Incorrect lines of transport, badly located, and built for temporary needs only, deteriorate or fall into disuse. The form of the system is largely due to its genesis and

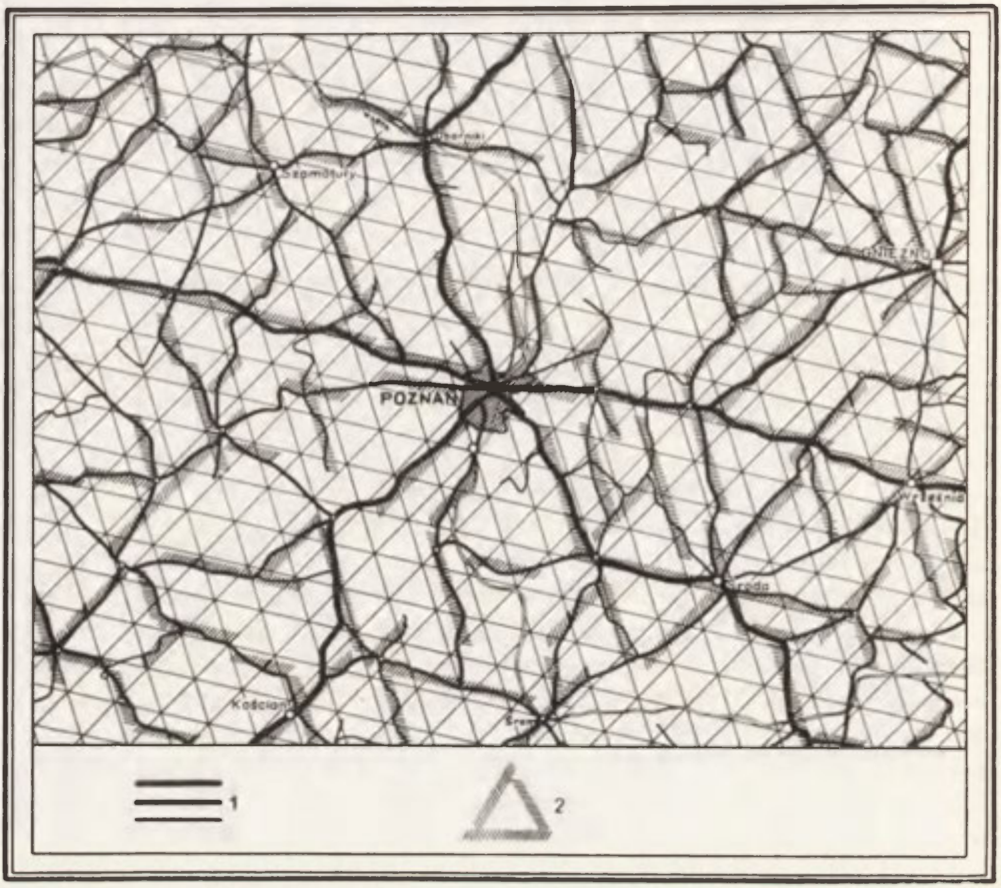

Fig. 1. Road network in the middle part of the Poznań voivodship on triangular mesh.
1 — roads, 2 — directions of roads in accordance with the directions of triangular mesh

the conditions of its evolution. The system created by organic evolution is as a rule triangular, and can be found in its most regular form in Europe. The system shaped arbitrarily, as in areas colonized by Europeans, is rectangular, and has been established most consistently in North America. The degree of conformity of geometrical systems with actual is shown in Figs. 1 and 2.

The geometrical systems are based on some rather simplified assumptions. In consequence, their theoretical and practical value, although doubtless, is restrained however. This is less evident as long as real systems are under analysis, but becomes striking when optimal systems are conceived in regional planning. What are these assumptions? (1) The homogeneity of transport; (2) the homogeneous use of geographical space; (3) statics.

The real conditions for the development of transport are much more complex. So, the transport is not homogeneous but differentiated. Various forms

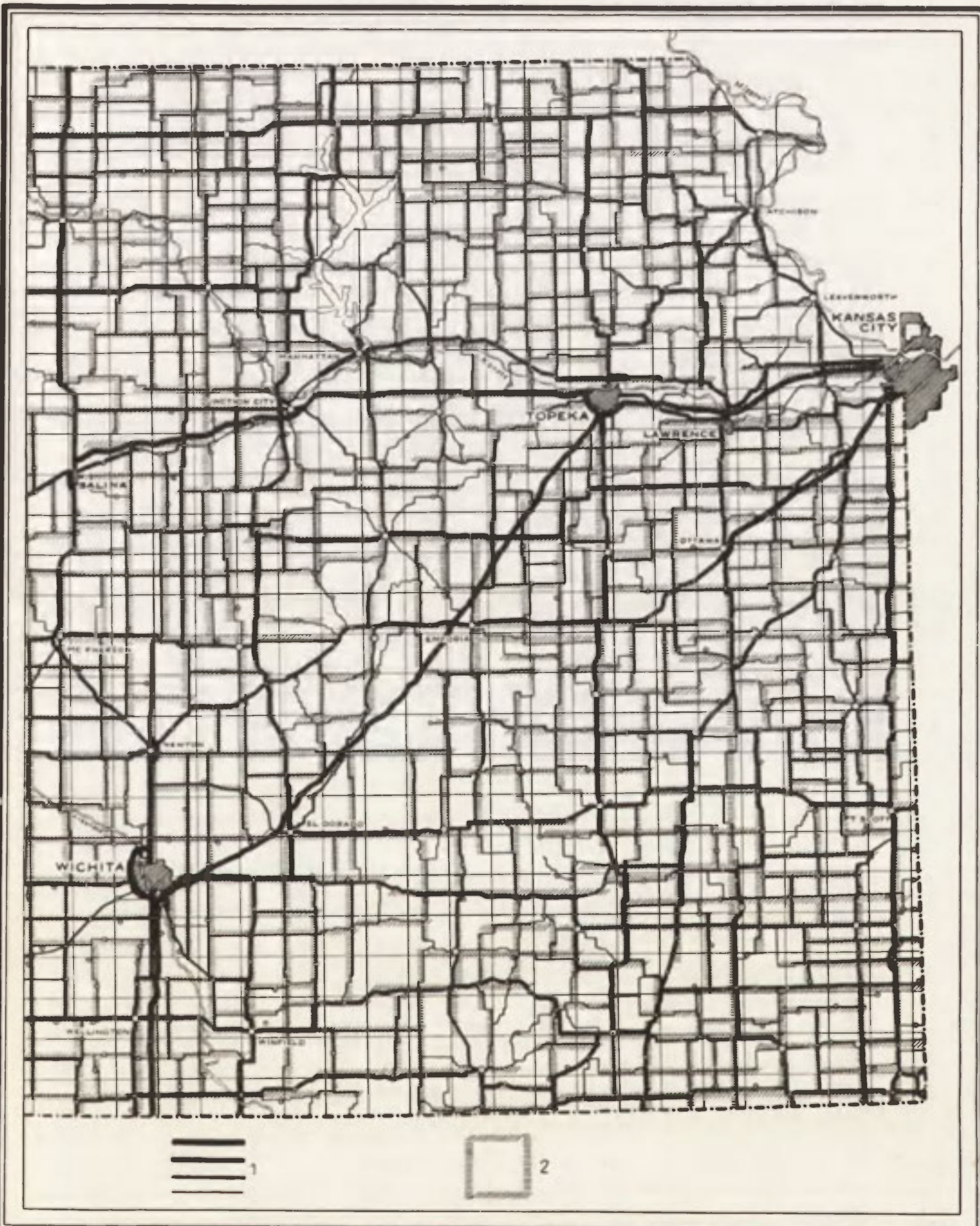

Fig. 2. Road network in the eastern part of the State of Kansas on the square mesh.
1 — roads, 2 — directions of roads in accordance with the directions of square mesh.

of transport have various qualities and fulfil various functions. In reality we find in each region various forms of complexes of transport lines. In complexes of transport lines, however, the regular pattern undergoes deformation; it deviates from the equilateral triangular or square pattern, because the reciprocal location of tracks of various forms of transport is not the same as the location of tracks of uniform transport serving the same area. Furthermore the geographical space is also used in various patterns, and this fact necessitates the deviation from the regular forms. Finally, the complexes of transport lines do not appear in a finished form but grow up gradually, and this is also reflected in their morphology.

If we wish to make a model of the transport network more real and correct than the two mentioned above, we must add three further premises which will complicate the system, which will make it more real, and on the basis of which the nature and forms of the deviation from the regular spatial structure of transport should be analysed.

There is no such model as yet. The adaptation of patterns already constructed for other purposes (telecommunication, trade, urban planning), in the form of sets of equations, can be of a certain heuristic importance. With their help a few partial transport problems can be solved, such as plotting the site of a transport junction on the basis of the distribution of transport points to be linked by the smallest network possible [2], plotting the shape of the centripetal network on the basis of the central junction and the number of transport lines and their termini [3], the delineation of the shortest artery linking n settlements [4]. Transport lines and their junctions may be also treated jointly in planning the homogeneous transport network [5].

The anisotropic model proposed by the author is an attempt to present the complex of the transport networks theoretically. Although this model has been presented in the geometrical shape, its substance consists not in its shape but in establishing the interdependences between the conditions of forming the transport network and its spatial structure. These interdependences are presented in the form of three principles.

Simple but steadily-repeated structural transport relations are the point of issue for the anisotropic model. These comprise: the ratio of safflux to transport proper by transfer transport and the ratio of transfer transport to direct transport. The relationships between main and secondary tracks are their external form expressed in a network's permanent equipment. From these relationships author deduces, using the principle of transport breaking (refraction) (principle I), the elementary complexes of transport lines endowed in their embryo state with some elements of the spatial structure of transport-network complexes. The refraction principle, which is a modification of the Fermat physical principle earlier interpreted from the viewpoint of transport, says that broken transport is cheapest when it breaks in such a manner that the *sinuses* of the angles of incidence and refraction of transport lines are inversely proportional to the cost units of both the transport forms. The location of roads towards railways is the most essential in modern transport-line complexes. Fig. 3 presents elementary road-rail complexes deduced from the real costs of rail and motor transport, as registered in countries typical for the large geographical zones (Western Europe, the U.S.A., India).

The observation of the evolution of the transport-network complexes reveals further interdependences which are of significance in explaining their spatial pattern. The reciprocal localization of various transport systems is characterized by a persistent repetition, which has been defined as the

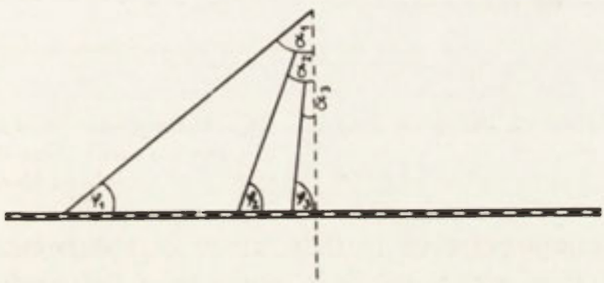

Fig. 3. Elementary complexes of transport lines. Location of a road in relation to a railway

principle of transport lines parallelism (principle II). It has been observed that lines of the new systems tend to be localized perpendiculary to the lines of the older systems, and then, because of some intermediary stages, change to the parallel position. Railways, for example, in relation to rivers or canals, are projected to link or supplement them, for a certain time develop as their equivalents, but finally replace them. The same process occurs in the relationships between roads and railways. The railways change the function of roads and take over transport to main destinations, diminishing the role of roads to that of local-transport lines. In consequence the trend of investment changes: investment in main-destination lines decreases, while that in directions perpendicular to and radial to railway stations increases. But with advance of motor transport, investment turns to directions parallel to railways. New transport forms first conquer these parallel directions, which are insufficiently served by the old transport systems or overburdened with various kinds of freight necessitating the use of differentiated transport forms. Thus bundles of transport lines are created. These cyclical changes in location express changes in the reciprocal relationships of costs in competing transport systems.

The elementary complexes deduced on the basis of the principle of refraction must be supplemented then by an additional factor resulting from the principle of parallelism, i.e. by the parallel transport lines (Fig. 4).

The transport lines which form network complexes are characterized by some features depending on directions. These features have been called anisotropic, by analogy with the anisotropy of the physical qualities of materials. Features characterizing transport lines running in main and secondary directions show the most obvious dissimilarities. Anisotropy characterizes transport-network complexes even in those areas least differentiated from the physical-geographical viewpoint. This results from the requirements of the transport itself and from the anisotropy of the spatial use of the geographical area. The most obvious manifestation of anisotropy in the spatial use is the concentration of settlements, population, and production along transport lines and particularly main arteries.

Fig. 4. Parallelism of transport lines

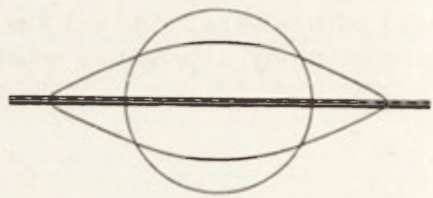

Fig. 5. Reorientation of marketing area (or services area) along the main transport line.

The differentiation of the spatial structure of the transport network is closely related to uneven condensation of economic activity in the geographical area. This differentiation can be explained and described in two ways, assuming either 1. changes in the marketing areas, or 2. condensation of transport masses. In each case we come to the conclusion that the system of secondary transport lines deviates from the regular pattern along main arteries, and this deviation occurs in the form of a flattened pattern of secondary lines (principle III).

Changes in marketing areas are influenced by improvement of the transport system by such means as the redevelopment of transport lines, introduction of new cars etc. These areas then become somewhat alongated and flattened along the perfected artery. This process is shown in Fig. 5. During our investigations we have succeeded in expressing this flattening by a mathematical function: $K = \psi \cos a + c$, where K signifies the shape of the area, ψ — the coefficient of proportionality, and c a constant independent from direction. It is obvious that such changes in marketting areas must involve a deviation in the pattern of secondary transport lines. The peripheral lines

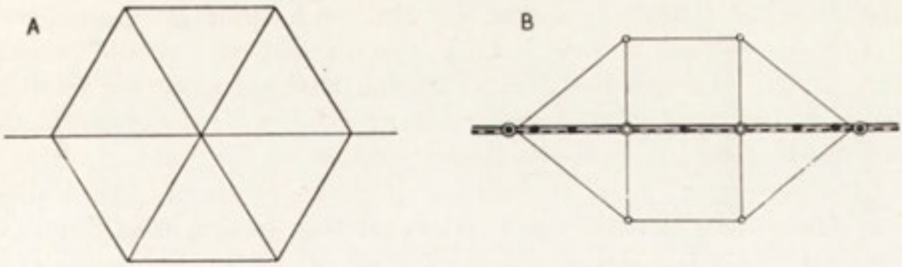

Fig. 6. Deviation of the transport line pattern,
A — Hexagonal-triangular regular pattern, B — Anisotropic pattern.

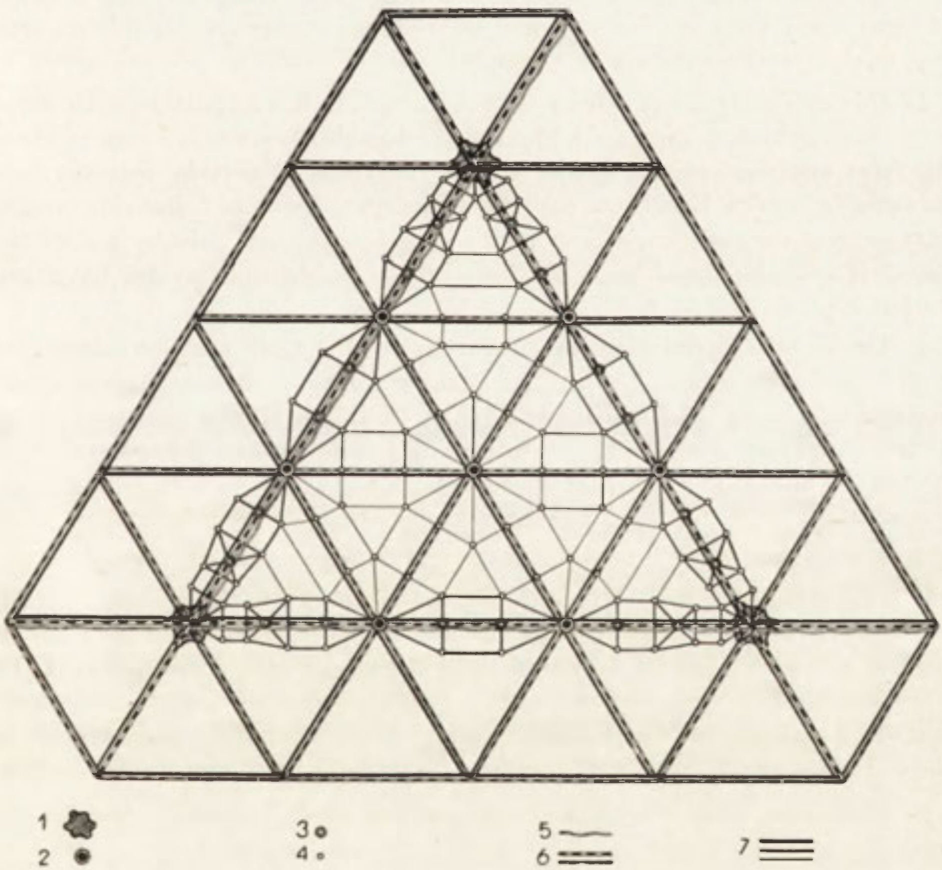

Fig. 7. Anisotropic model of a transport-network complex.
1 — I class junctions, 2 — II class junctions, 3 — III class junctions, 4 — IV class junctions, 5 — rivers 6 — railways, 7 — roads.

become flattened (almost in accordance with the function $K = \psi \cos a + c$), and short feeder lines deviate towards the perpendicular position because economic centres become more dense. Having accepted a greater density of transport masses in junctions as the starting point, we find the proper method for solving the problem to be the tensor calculation.

Fig. 6 presents the joint results of these partial supplements and deviations. On the left in shows the pattern of transport lines in simplified conditions, on the right that in complex conditions. The second pattern is a basic element in the anisotropic model, which constructed of such elements, is presented in Fig. 7.

The anisotropic model is more economical than the regular one. It is more adaptable to the differentiated distribution of the transport masses, takes into account their density or sparsity, and aims at securing the efficient transportation in congested zones. Scale economies are greater in such a system of transport lines and transport masses, because it renders possible an effective use of modern means of transport.

Is this model realistic, and to what extent is it compatible with actual transport-network complexes? The answer to this question is given by checking the theoretical results achieved. As the value of certain features in an anisotropic model has been expressed not synonymously but in brackets (classes) and inequalities, a clear picture can be achieved only by a statistical check. Thus, the three basic features of the anisotropic model have been statistically verified.

1. The significant relationship (hierarchy) of the main and secondary transport lines, as measured by the size of transports. In the anisotropic model, transport mass on the main lines is bigger than the sum of transport masses on the secondary lines being her branch-off. Thus we can note that:

$$\Phi_1 > \sum_{j=1}^{n} \Phi_{2j}.$$

where Φ_1 — the stream of traffic on the main line, Φ_2 — the stream of traffic on the secondary line. This feature can only be checked by using the sampling method as checking must be based upon detailed traffic measurements. The sample analysis was carried out in the Poznań voivodship, and it was found that the coefficient of comptability between the real and the theoretically-deduced values amounts to 0,92 (complete compatibility being taken as 1.00).

2. Flattening of the secondary-line system along the main line. In the anisotropic model flattening is expressed by the inequalities:

$$\frac{X_a}{Y_a} > \frac{X_h}{Y_h} \qquad 60° \leqslant \varphi_2^{x} < 90°$$
$$\varphi_2^{\omega} < 60°$$

where X_a, X_h signify the longitudinal axis (main line) in the anisotropic and hexagonal regular pattern: Y_a, Y_h — the transversal axis of the respective patterns, φ_2^*, φ_2 — the inclination of the secondary lines: feeder line and peripheral line to the main line. The checking covered all the most important transport regions in the world, and 890 complexes were found. The comptability coefficient amounted to 0.84.

3. The quantitative ratio of transport lines of various systems converging in a junction. In the anisotropic model this ratio is constant and amounts to approximately 2.00.

$$\frac{S_2^{\omega I}}{S_1^{\omega I}} \approx \frac{S_2^{\omega II}}{S_1^{\omega II}} \approx \frac{S_2^{\omega III}}{S_1^{\omega III}} \approx \text{const.}$$

where S_1^{ω} — the number of main lines in a junction, S_2^{ω} — the number of secondary lines in a junction, and I, II, III — classes of junctions. This feature was checked in 367 most importand world junctions. The standart deviation, which in this case is the appropriate measure, amounts to only 0.77.

The wider is the scope of interrelations to be taken into consideration, the less satisfactory is one single model and the more necessary is its extension and concretization. We can achieve this by differentiating many types. This facilitates the cartographic verification of theoretical results. This problem was developed by the author of the present paper in his "Complexes of transport networks" [6].

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GEOGRAPHIA POLONICA 2,1964

INFLUENCE OF TRANSPORT LINES ON CONCENTRATION OF POPULATION AND INCREASED COMMUTING IN WARSAW REGION

Teofil Lijewski

The region round Warsaw is one of the areas with the quickest growth of population in Poland. While in 1946-1961 the national average rose by 26%, the index for the Warsaw voivodship increased by 37% or even more in the close vicinity of the capital. At the same time this is an area in which concentration of population is to a great extent influenced by transport lines, particularly railways.

A rapid increase in metropolitan agglomerations is a phenomenon well known all over the world. But the development of Warsaw has also been influenced by some additional factors, such as expansion of industry, great centralization of administration and of academic and cultural life, and the need to rebuild the destroyed capital. The destruction of Warsaw has also necessitated the rapid growth of suburban settlements round the capital. Since 1954 this has also been accelerated by the introduction of new restrictions on the influx into Warsaw which has caused new inhabitants to settle in suburban areas with easy transport to the capital.

The correlation between distance from the capital and convenient transport to it on the one hand, and the increase of population on the other, can easily be seen from Table 1, in which towns have been grouped by position in relation to Warsaw and to railways. Towns forming a tight agglomeration round Warsaw and with a travelling time of less than 45 minutes to the centre of the capital have been included in the inner-suburban ring. Those situated farther away, but linked with Warsaw by everyday commuting to work, belong to the outer-suburban ring.

It is quite typical for the speed of urban development to have been so largely differentiated since the war. It seemed quite likely that the development of transport would equalize the chances of development for all towns, as on the one hand it would level the effect of distance, and on the other hand would lessen the role played by the railways, owing to the development of road transport. In reality, however, the reverse has occurred. Since the war the influence of the railways, particularly the electrified ones, has become even more evident, whereas towns deprived of railways have been characterized by stagnation of population.

TABLE 1. GROWTH OF POPULATION IN TOWNS OF THE WARSAW VOIVODSHIP IN 1921—1960 BY POSITION IN RELATION TO WARSAW AND RAILWAY LINES

Groups of towns	Growth of population in percentages		
	1921-1939	1946-1960	1921-1960
Towns of the inner-suburban Warsaw ring	69	89	257
Towns of the outer-suburban Warsaw ring	46	54	34
Distant towns	29	20	0
Towns along electrified railways	64	76	186
Towns along standard-gaugr non-electrified railways	31	36	26
Towns along narrow-gauge railways	22	21	9
Towns without railways	20	3	—43
Towns of the Warsaw voivodship — total	38	45	53

Almost entire increase of population in the inter-war and post-war periods fell on towns and settlements round Warsaw, the great majority of them having been built during that time, as the old urban network had been very loose in this area. In the inner-suburban Warsaw ring only four towns have a historical past, Blonie (city status in the 14th century), Piaseczno (15th), Grodzisk Mazowiecki and Karczew (16th).

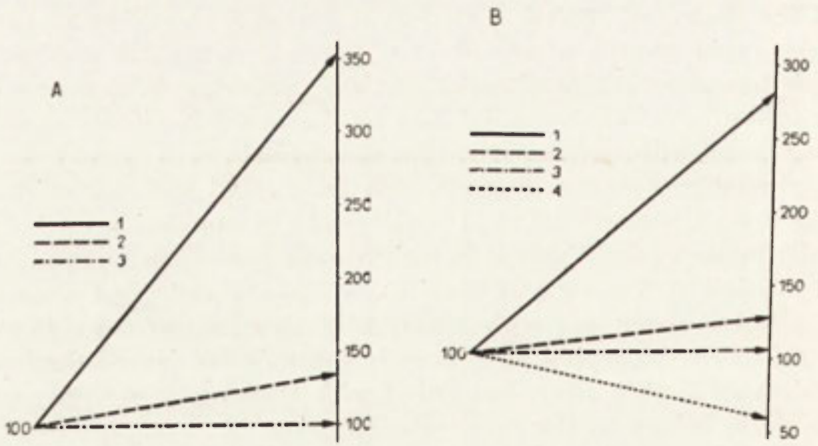

Fig. 1. Indices of growth of population in towns of the Warsaw voivodship in 1921—1960

A. by the distance from Warsaw, 1 — towns of the inner-suburban Warsaw ring, 2 — towns of the outer-suburban Warsaw ring, 3 — other towns, B. by transport position, 1 — towns along electrified railways, 2 — towns along other standard-gauge railways, 3 — towns along narrow-gauge railways, 4 — towns far from railways

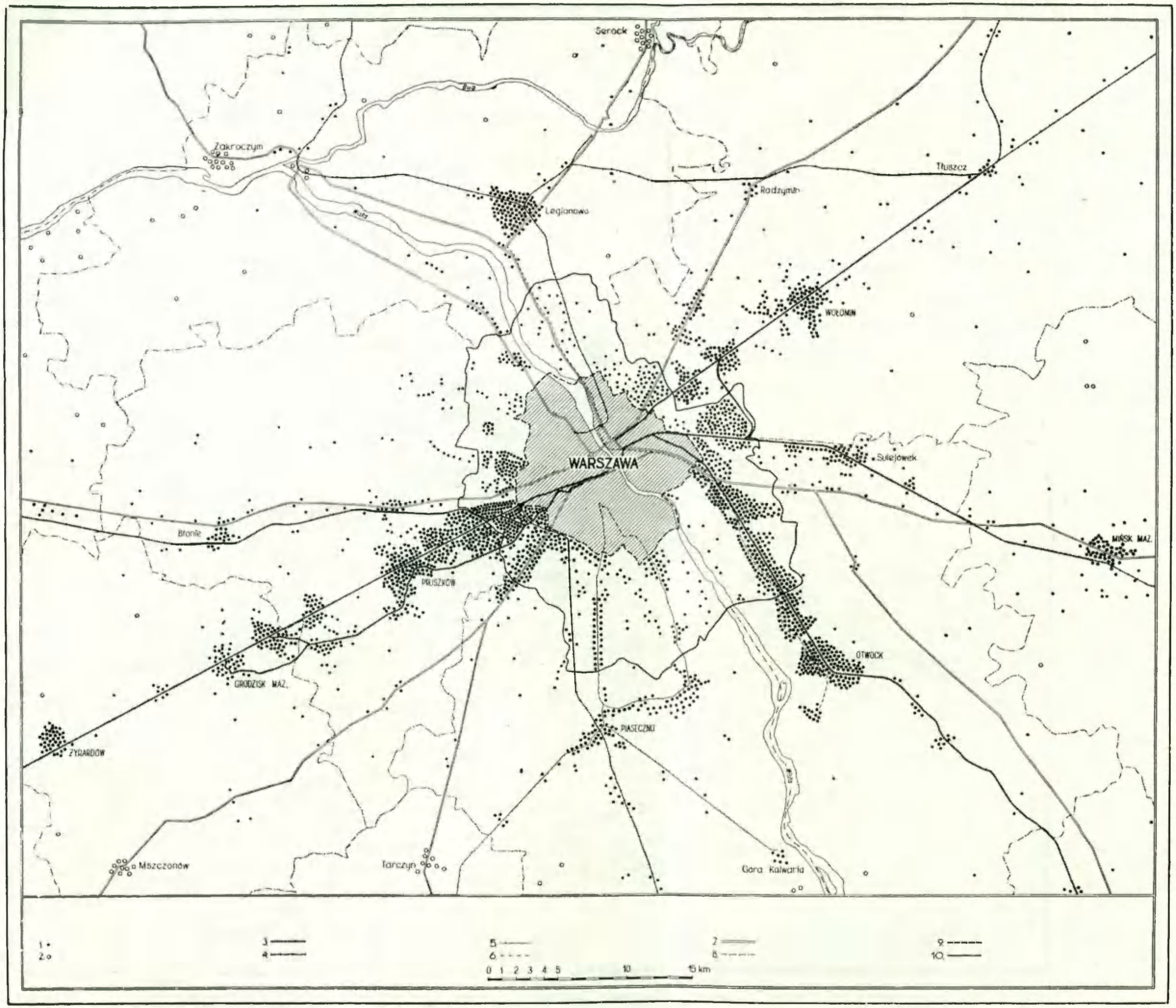

Fig. 2. Changes in population of the Warsaw Region from 1921—1960

1 — increase of 200 persons, 2 — decrease of 200 persons, 3 — electrified railways, 4 — others standard-gauge railways, 5 — narrow-gauge railway, 6 — railways closed, 7 — main highways, 8 — boundaries of *powiats*, 9 — boundaries of Warsaw prior to 1951, 10 — boundaries of Warsaw after 1951.

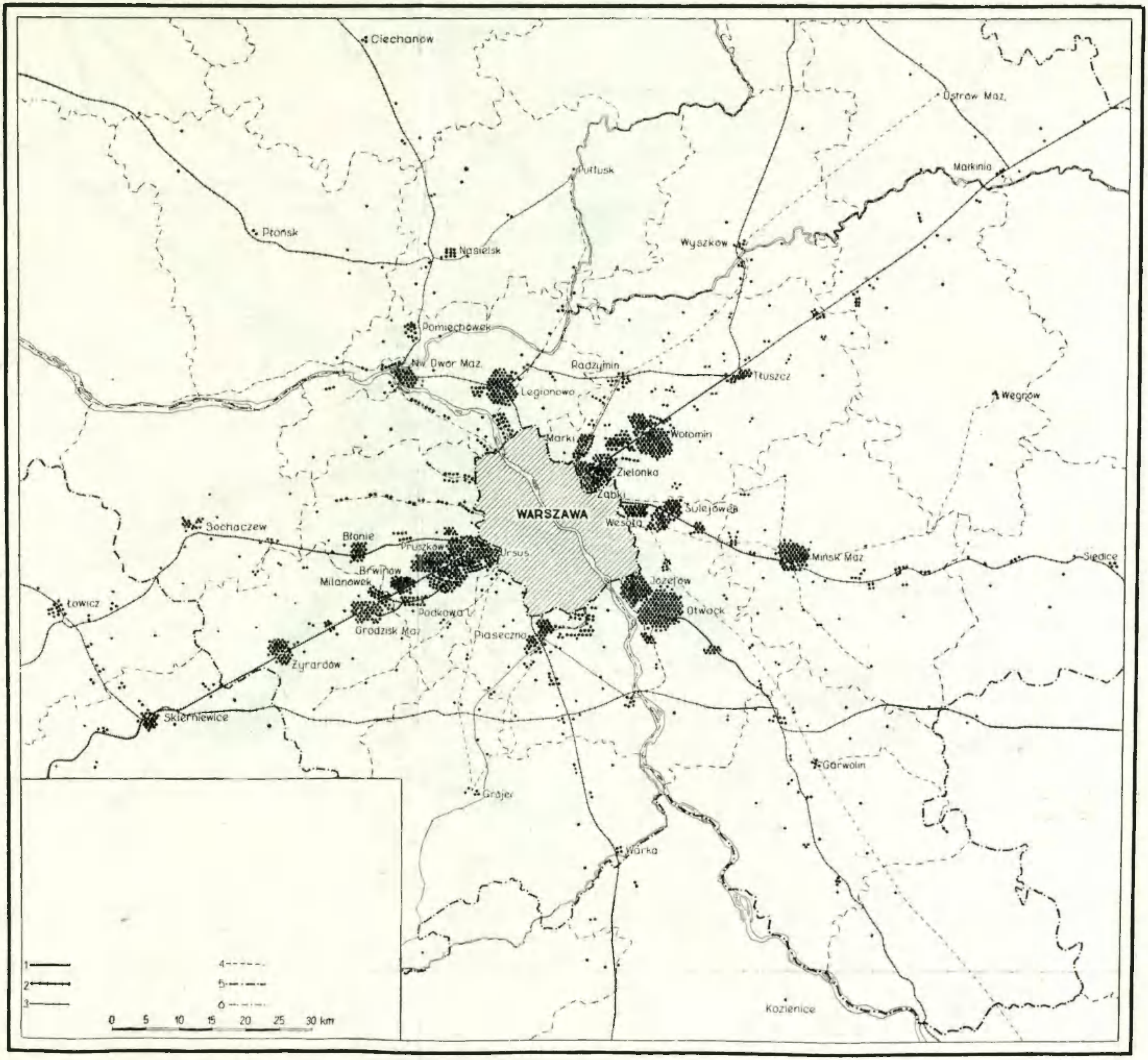

Fig. 3. Places of residence of people commuting to work in Warsaw according to 1959 data collected by the Bureau of Regional Planning of Warsaw

1 point means 50 people commuting every day. 1 — electrified railways, 2 — non-electrified railways, 3 — narrow-gauge railways, 4 — coach services, 5 — boundaries of voivodships, 6 — boundaries of *powiats*

The Warsaw agglomeration now comprises seventeen towns and six urban settlements, excluding the capital and two former towns (Włochy and Rembertów) already incorporated within the Warsaw boundaries. Ten towns and two settlements have a population exceeding 10,000. In 1946, only three towns exceeded this limit, in the inter-war period four. Ten towns were granted city status only after the war.

The characteristic feature of all new towns and settlements is their close link with the railway system. All of them have grown up along railways, and particularly around railway stations. Consequently, the Warsaw agglomeration is star-shaped, with numerous arms along railway lines.

The various arms differ in length and population according to the age of each railway. The oldest lines have attracted the greatest numbers of inhabitants, and consequently the longest ribbon of towns, ending with Grodzisk at a distance of 30 km from Warsaw, extends along the Warsaw — Vienna railway, opened in 1845. In 1960 about 113,000 people lived in this area, comprising six towns, and about 140,000 if we include Włochy, a borough of Warsaw incorporated in 1951.

The ribbons of urban settlements along railways which started between 1862 and 1877 on the right bank of the Vistula are slightly shorter but also compact. They extent as far as Otwock (28 km), Sulejówek (20 km), Wołomin (20 km) and Legionowo (20 km).

A certain number of urban settlements also developed along the narrow-gauge lines built between 1892 and 1914, such as Marki, Jeziorna, Skolimów-Konstancin, Zalesie Dolne and partly localities in the Otwock ribbon.

The least developed ribbon of settlements is situated along the newest railways. There is only one new recently-built settlement (Ożarów) along the Kalisz railway built in 1903, and an old town, Błonie, which owing to the new railway has grown in significance. The Radom railway, opened in 1934, has not as yet created any ribbon of urban settlements. Piaseczno, situated along this line, is an old town which developed along older narrow-gauge lines, so perhaps only the settlement of villas at Zalesie Górne may start its ribbon of settlements.

The electrification of railways is another factor influencing the degree of concentration of population, since it accelerates commuting, increases the number of trains, provides new termini in the centre of the capital, and in consequence also accelerates the development of settlements along the electrified lines. The greatest number of people is concentrated along the three oldest electric lines (to Żyrardów, Otwock and Mińsk Mazowiecki). The influence is obvious two-way, these lines had the greatest number of passengers and were electrified first.

The influence of an electrified railway is quite clear from the example of Wołomin, for instance, which began to grow rapidly after 1952 when the railway was electrified, or of the Radom line, where the sparse population is a result of the lateness of electrification, in 1962.

The comparison between the Otwock and Legionowo lines is striking. Both run through similar areas of sands and woods, both were started in 1877, and neither reaches any greater settlement in its suburban sections; but by 1960 50,000 people had settled along the Otwock line outside Warsaw boundaries, and the same number again within Warsaw boundaries in the area between Wawer and Falenica. Along the Legionowo line, however, there is only the one town of Legionowo with 20,000 inhabitants, and a few small settlements with some thousands of inhabitants within the boundaries of Warsaw. This is largely due to the fact that the Otwock line was electrified in 1936, but the Legionowo line has not been electrified even yet. During the inter-war period their increase in population in absolute figures was almost the same, but since the war Otwock has grown twice as quickly (during 1946—1960 the population of Otwock grew by 24,000, and that of Legionowo by 12,000).

A similar phenomenon of concentration of population along railways also occurs in areas situated farther from Warsaw but still linked to it by commuting. There is no trace, however, of compact ribbon-settlements along the railway, and the population grows either in separate towns and urban settlements (e.g. Tłuszcz, Mińsk Mazowiecki, Sochaczew, Żyrardów) or in villages conveniently situated in the vicinity of railway stations (e.g. Pomiechówek, Teresin, Jaktorów, Międzyborów, Celestynów).

At the same time, areas far from railways are characterized by stagnation or even a decrease in the number of inhabitants (e.g. the northern edge of the Kampinos Forests). The same situation arises in towns not connected with Warsaw by any railway (Zakroczym, Serock, Mszczonów, Tarczyn). They now have fewer inhabitants than in 1921, owing in part to war damage and to the extermination of persons of Jewish origin, and in part to the fact that their population not only ceased to grow after 1946, but has actually declined in some towns of the voivodship situated far from the centre.

Unlike the railways, road transport in the Warsaw region has not induced any development of greater settlements, although existing coach lines run quite frequently and the number of private motor vehicles, particularly motor cycles, is increasing rapidly. The sole exceptions are settlements bordering on Warsaw, and particularly those connected with the capital by municipal bus services (Łomianki, Raszyn, Jabłonna).

The concentration of population in settlements along railways reveals the true character of these settlements as Warsaw's satellite towns. Their main function is to provide residences for people commuting to work in Warsaw. Whereas in the pre-war period a certain part of the population consciously migrated to suburban settlements for health reasons or cheaper land, nowadays the majority live there because they have to, as there is still insufficient accomodation in Warsaw or they have been refused permission to settle in the capital. Former holiday bungalows, built predominantly of wood, which used to be lived in only during vacations, have become homes lived in throughout the year, although they are mostly unsuitable for this purpose.

This divergency between places of residence and of work has consequently induced mass commuting to Warsaw much greater than in the pre-war period. In 1938 c. 20,000 people commuted to Warsaw, but as many as 120,000 in 1960 despite the fact that the administrative boundaries of the capital have been expanded. About 80% commute by railway, the rest either by coaches run by the State Coach Transport and by their respective factories, or by private vehicles.

The places of residence of people commuting to Warsaw are distributed in the same pattern as the increase in population. They are largely the same people. The increase in population round Warsaw is due either to the influx of inhabitants seeking easy commuting to Warsaw, or to natural increase among local people, who cannot find occupation in their places of residence and have to work in the capital.

Some suburban settlements have developed their own industries, which employ part of their inhabitants. This has happened mostly on the left bank of the Vistula, and particularly along the oldest Żyrardów line (Ursus, Piastów, Pruszków, Milanówek, Grodzisk Mazowiecki, Żyrardów). But even so the number of their inhabitants commuting to Warsaw is still considerable while they receive as commuters the inhabitants of some more distant towns or surrounding villages. A typical example is Pruszków, from which 6,000 commute, mostly to Warsaw, and to which 5,000 commute at the same time.

Towns on the right bank of the Vistula do not possess any larger factories or enterprises and are typical dormitory residential settlements, though there are exceptions, such as Wołomin with its industries and Otwock with its sanatoria and research institutes, which attract more than 2,000 commuters to it, mostly from Warsaw, while at the same time some 10,000 commute away from it.

After the war certain efforts were made to disperse Warsaw industry, and build new factories in suburban settlements. New factories have been built and some old ones expanded in Ursus, Pruszków, Ożarów, Sochaczew, Piaseczno, Wołomin and elsewhere. But at the same time factories have also been built or expanded in Warsaw, because of such factors as the obvious attractions of the capital, the concentration of numerous highly skilled workers, the proximity of research institutes, the market facilities, etc. This process has been accompanied by a rapid development of services, if only to meet the demands of Warsaw residents.

As manpower is scarce in Warsaw, this further industrialization not only maintains but increases mass commuting, and the main factor inducing concentration of population along transport lines in the Warsaw suburban zones remains in force.

There is no other example in Poland of such obvious mass agglomeration of population along transport lines. This phenomenon also occurs in Upper Silesia, the Gdynia region, and around Łódź, Cracow, Poznań, and other big towns, but nowhere it is of such an extent and dynamic development as in the Warsaw agglomeration.

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POLISH SEA-PORTS, THEIR HINTERLANDS AND FORELANDS

JULIUSZ MIKOŁAJSKI

INTRODUCTORY NOTES

New economic structures of geographical regions resulting from political changes impose a readjustment of the various economical elements which formerly got their shape in other structures. If the integration takes place rapidly and smoothly and is at the same time combined with a pronounced dynamism of growth of particular elements of the economical structure, then it might be said that in the new economic-geographical structure and also in the new system these elements have found their optimal conditions of development. For instance, the port of Gdańsk having extended its hinterland after World War I to the whole territory of the new Polish State, within a few years grew from an unimportant Baltic port to a first-rate port with its traffic increasing from about 2 million tons in 1911-1913, to more than 8 million tons in 1920. Even the construction of the new port of Gdynia at a distance of some 15 km from Gdańsk did not interfere with its growth as is illustrated by the statistics of its prewar traffic. Both ports had the same hinterland i.e. above all the territory of the Polish State. Its growth took place inspite of continuous controversies between the Free City State of Gdańsk and Poland. After World War II the port of Gdańsk became a Polish port showing a rapid expansion after its complete decline in 1945 (Fig. 3).

A similar phenomenon can be observed in the case of the port of Szczecin. Fig. 1 illustrates its rapid recovery after World War II in spite of its complete destruction. Szczecin has become the greatest port in Poland and at the same time the greatest Baltic port.

The great sea-ports of Poland are located at the two confines of her coast because of the geographic-political situation of her territory. The two great ports Szczecin and Gdańsk owe their origin to their geographical environment. They are located at the mouth of two rivers which, before the existence of the railway, formed natural traffic arteries. After the completion of the railway net the main railway lines leading to the Baltic Sea followed the natural routeways of the Vistula and Odra terminating at the sea-ports of Szczecin and Gdańsk.

The above notes are of great significance because they are related to such basic problems as the hinterland as well as the foreland of ports and to geographical aspects of planning. Therefore it is necessary to approach some problems dealing with port-geography from the methodological standpoint, the more so since they are continually full of interest and many terms have not been strictly defined. A sea-port constitutes an important item of study in economic geography because it reflects the economic structure and its disposition in a geographic economical region called the hinterland. In addition to this concept, the term foreland has recently been introduced, making it possible to get a further understanding of port geography.

Polish sea-ports (Gdynia, Gdańsk, Szczecin) and their economic characteristics

The situations of the three Polish ports in regard to the sea are different. The port of Gdynia has the most advantageous situation because it is close to the sea, has deep roads and being built after World War I is the most modern Polish sea-port.

Close to the youngest Polish port, at a distance of some 6 km from the sea, lies her oldest port, the port of Gdańsk whose documents reach back as far as the end of the 10th century.

The port of Szczecin is situated at a distance of 65 km from the sea, near the mouth of the Odra River into the Haff of Szczecin which makes possible

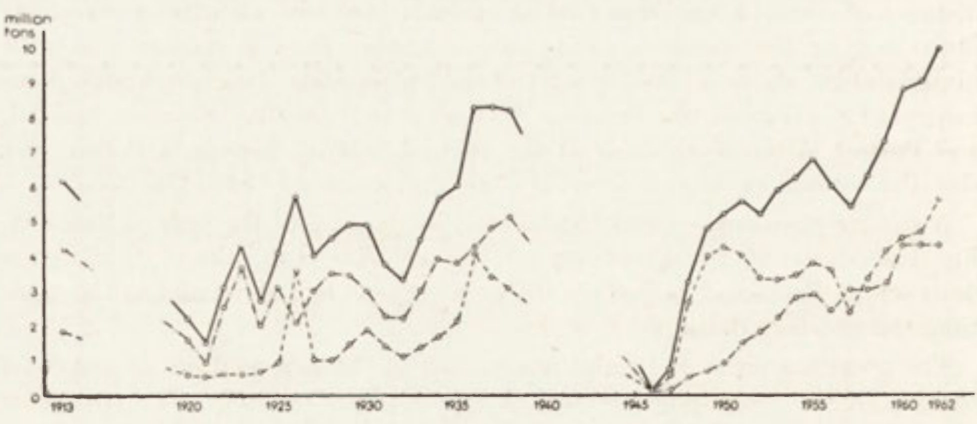

Fig. 1. Total traffic, export and import of the port of Szczecin
1 — Total traffic, 2 — Export, 3 — Import

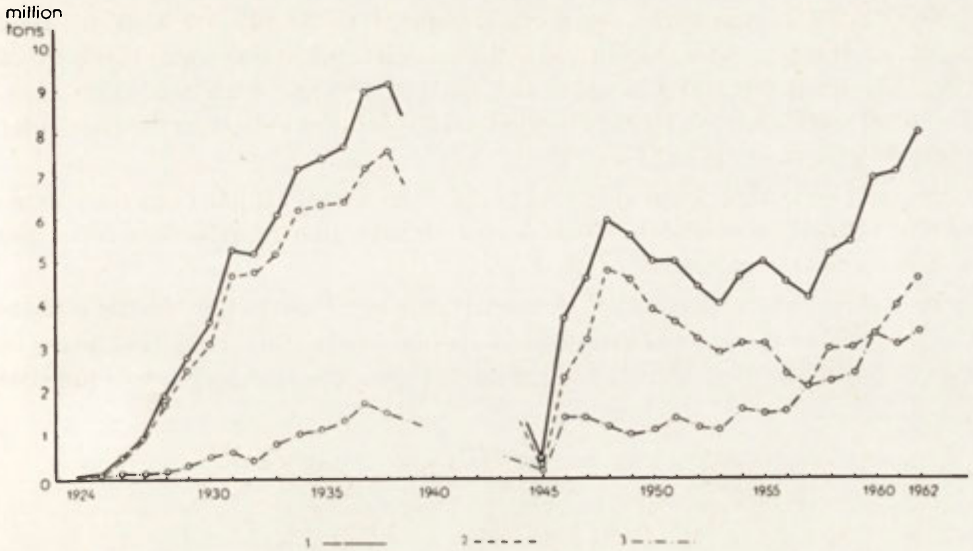

Fig. 2. Total traffic, export and import of the port of Gdynia
1 — Total traffic, 2 — Export, 3 — Import

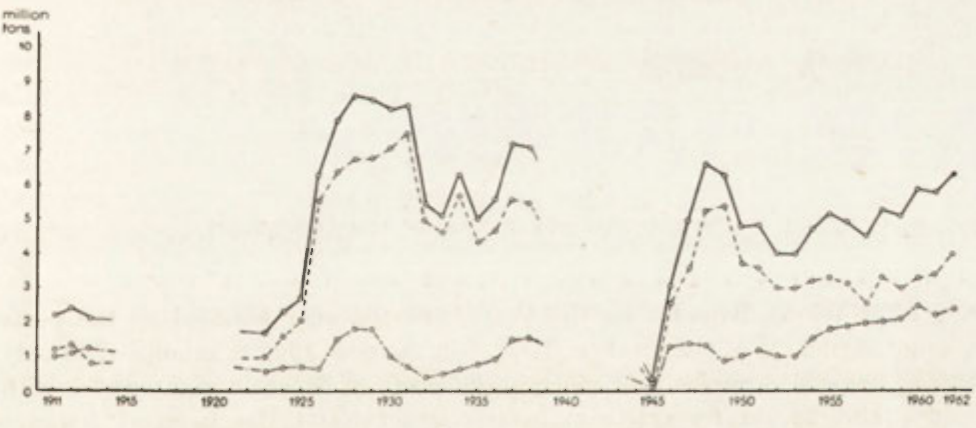

Fig. 3. Total traffic, export and import of the port of Gdansk
1 — Total traffic, 2 — Export, 3 — Import

the extension of water transport for sea-going ships into the interior and a direct linkage with inland water transport.

The traffic of the ports up to World War I and after it is illustrated by Figs. 1–3. The rapid expansion of the traffic of the ports not only shows the pace of their recovery after war damage and destruction but also the rapid integration of the port of Szczecin with the Polish Republic within her new political frontiers.

The traffic of the three sea-ports amounted to 24,447,000 tons in 1962 of which the port of Szczecin participated with 9,989,000 tons, the port of Gdynia with 8,094,000 tons and the port of Gdańsk with 6,363,000 tons. The total traffic as well as its division into import and export in the particular years is shown by Figs. 1–3.

Szczecin and Gdańsk are universal ports whereas Gdynia has been transformed into a general cargo port. These details already give a fairly clear reflection of the national hinterland of that port.

To a great extent, particularly in export, the structure of port traffic reflects the geographic-economical situation of its hinterland. Coal held first place in export by weight both during the period between the two wars and immedia-

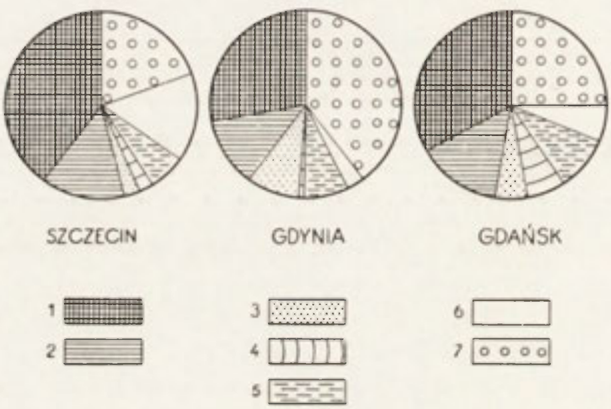

Fig. 4 Structure of traffic in 1962
1 — Coal and coke, 2 — Ore, 3 — Grain, 4 — Timber, 5 — Liquid cargo, 6 — Other bulk cargo, 7 — General cargo

tely after World War II. In the year 1949 the coal handled in the ports amounted to 71% of the total traffic, yet in the year 1962 it amounted to only 33%. Coal still occupies first place in the ports of Szczecin and Gdańsk with 30.9% and 32.6% respectively, in the structure of the handled tonnage (Fig. 4).

In all Polish sea-ports a favourable change can be observed not only in the structure of the traffic (Fig. 4) but also in its very good balance (Figs. 1–3).

Transit traffic participates with 17% of the total tonnage handled in the three ports. The principal transit port of Poland is Szczecin, through which passes 68.7% of the total transit traffic; the remaining transit traffic passes through Gdynia 18%, and Gdańsk 13.3%. As far as the proportion of transit traffic to the total traffic in the particular ports is concerned it amounts in the port of Szczecin to 30.4%, in the port of Gdynia to 9.9% and in the port of Gdańsk to 9.7%. From the standpoint of transit the geographical situation of the port of Szczecin is the most advantageous in respect to its exterior hinterland, if we look on the territory of Poland as its interior hinterland. Czechoslovakia as an exterior hinterland is of decisive importance to the Polish ports. The total transit traffic passing through the Polish sea-ports in 1962 was 4,447,500 tons, Czechoslovakia participating with 3,088,000 tons i.e. nearly 70%. Second place is held by the German Democratic Republic with 865,000

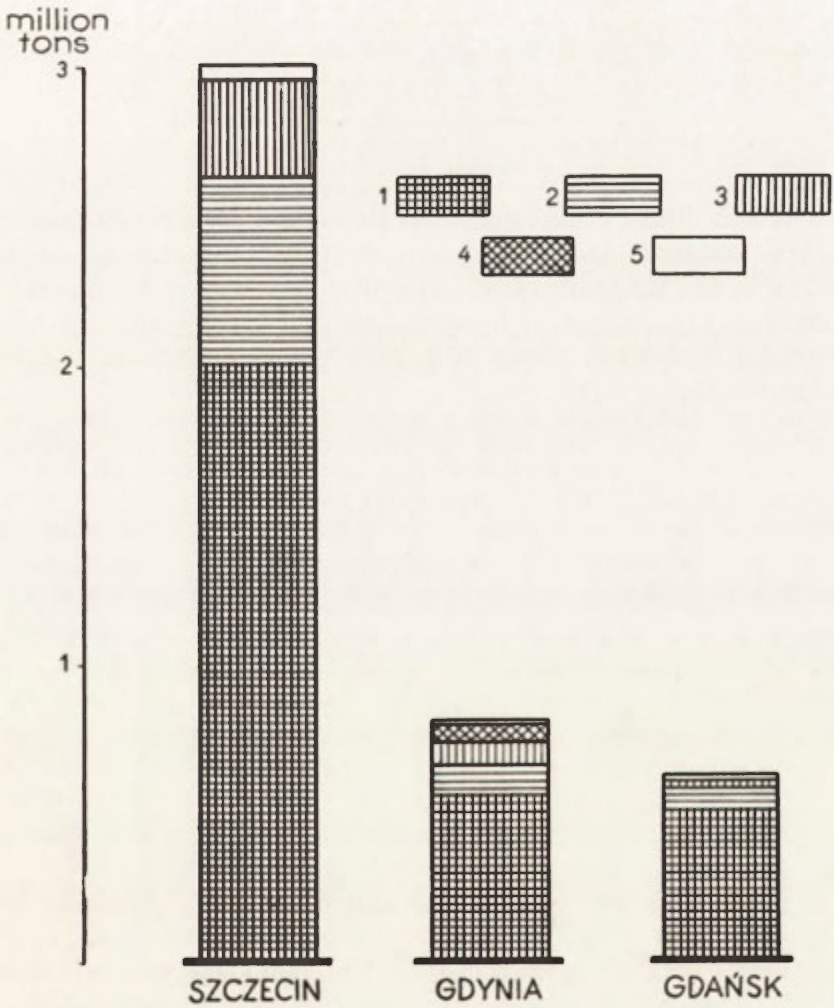

Fig. 5. Transit traffic according to countries
1 — Czechoslovakia, 2 — German Democratic Republic, 3 — Hungary, 4 — Soviet Union, 5 — Others

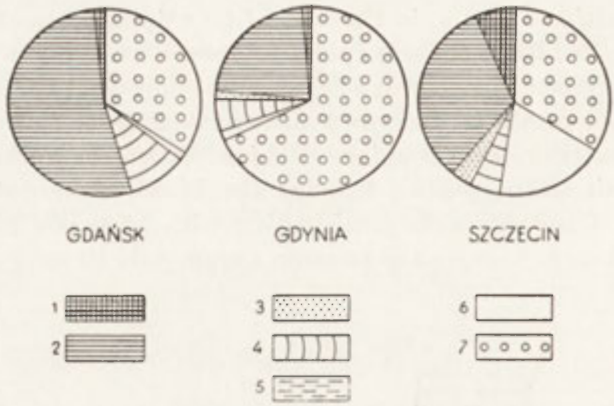

Fig. 6. Structure of transit traffic in 1962
1 — Coal and coke, 2 — Ore, 3 — Grain, 4 — Timber, 5 — Liquid cargo, 6 — Other bulk cargo, 7 — General cergo

tons (19%) and third by the Hungarian Republic with 498,000 tons (10%). These three countries make up nearly 99% of the total transit traffic. First place in the structure of transit traffic is occupied by general cargo (1,727,000 tons), second place by ore (1,493,300 tons) and third by wood (284,000 tons) these three groups of goods together amounting to 3,495,900 tons i.e. more than 70% (Fig. 6).

The concept of hinterland and foreland of a sea-port

Geographic-economic considerations of a sea-port are impossible without investigating its hinterland and foreland. Although the concept of the hinterland has been used for a long time it has not yet been strictly and adequately defined, neither have the methods which would allow it to be precisely delimitated. The following denominations of hinterlands can be found: natural, marginal, incontestable, contestable, basic, geographical, political with tariff walls, economic, kilometric, real, theoretical, empirical, regional, extraregional, national concerning a communication area, interior, exterior, facultative, import hinterland, export hinterland, exclusive, provincial, local, within political frontiers, international, foreign, supraregional, primary, secondary, primitive raw material hinterland, liner port hinterland, physical, static, [5-8, 10, 12-14]. It must be remembered that the hinterland may be different for each group of cargo [2, 4]. A simple parcelling out of an area behind the port is an inadequate interpretation of the concept of hinterland, as is correctly stated by Morgan [8]. In his opinion a port has a great number of hinterlands of various areas and structures. The main factors delimiting the different hinterlands of a sea-port are: 1) the nature of commodities, 2) the port equipment, types of ships calling at the port and the number of regular lines, 3) the influence of policy concerning communication by railways and inland waterways. On the basis of the interplay of these factors, Morgan distinguishes three types of hinterlands: 1) Primitive hinterlands belonging incontestably to one port because they have no other sea outlet or there are no transport lines to another port. 2) Raw material hinterland and its resulting bulk cargo needing specially designed ships such as ore boats, tankers etc. These ports are so located as to cut land transport of bulk commodities to minimum distances. 3) Liner port hinterlands are the most complicated. A primary hinterland is the area in which the port is well established; in the secondary hinterland there will be rivalry among the different ports. However, this classification is perhaps too simple. In particular it lacks a uniform criterion because the primitive hinterland is a spatial concept, a raw material hinterland as its name implies is a concept referring to a commodity and the third type is a concept of transport having more in common with the organization of maritime space as a link with the foreland of ports. A distinction between primary and secondary hinterland has been known in geographical literature as incontestable and contestable hinterland.

The concept of regional and extraregional hinterland has also been introduced where regional is synonymous with natural or geographical hinterland but without precisely defining the meaning of the terms geographical or natural. Such terms are of little value until the concept of natural hinterland has not been precisely defined. We know only that in the hinterland of different ports crossing and overlapping occur.

The concept of the natural hinterland may be identified in a certain geographic-political structure with the territory of a state. For example, the former Eastern frontier of the hinterland of the port of Szczecin was in the year 1937 exactly running along the western frontier of Poland [8]. The hinterland extending beyond the frontiers of a country can be only indirectly influenced by its policy. Here we are approaching the problem of transit. The question arises whether the German Democratic Republic and the Danubian States, above all Czechoslovakia, are the so called natural hinterlands of the Polish ports and in particular of the port of Szczecin. This opinion in held consistently on the basis of a single criterion i.e. the distance in comparison with other ports. Such a criterion is completely inadequate and simplifies the rather complicated problem of hinterlands. The territory of Czechoslovakia constituted in the period between the two wars and constitutes at present the hinterland of Polish sea-ports, especially of the port of Szczecin. Yet Czechoslovakia was in the period between the two wars and is at present the hinterland of a great number of ports situated on the long coast line between the mouth of the river Vistula and the mouth of the river Rhine. The first place was occupied by the port of Hamburg and Bremen, Lübeck, Emden and even the small port of Sassnitz (on the Isle of Rügen) had also some transit traffic with

Czechoslovakia. To these must be added the ports in southern Europe, in particular the port of Rijeka and the port of Trieste. Is it now possible in such a structure to consider Czechoslovakia as the contestable hinterland of a number of ports? Or does her territory constitute a contact zone of the hinterlands of these ports? Or does such a structure perhaps reflect the central-geographical situation of Czechoslovakia? These do not seem to be the decisive factors. To solve this problem or at least to approach to the heart of the matter, the concept of foreland proves to be very useful. This concept was first introduced to geographical literature by the Polish geographer Berezowski in 1949 [5] but without investigating the matter further. It was only in 1950 that Weigend [12] applied himself to the study of this concept thinking that the term foreland had never been previously used in connection with sea-ports. However, he was the first to draw attention to the significance of foreland in the study of port-geography presenting a classification of forelands as well as examining the forelands of the port of Genova in 1938 and 1955 [13].

Generally speaking, not much has been written in this field of port geography. The one Polish article dealing with the problem of foreland is that by Barczuk [3]. This article not only describes the forelands of Polish ports but also the proportion of export to import to and from the forelands. The European States occupy first place, the Far East second and third place is occupied by North America. In 1959 Europe again occupies first place, South America second place, Asia third place and North America fourth place [15].

The problem of foreland mainly arises when transit is concerned. Czechoslovakia carries on foreign trade with more than 100 countries and a large proportion of this consists of sea-borne traffic. The forelands indicate the directions of her sea-going foreign trade. Since Czechoslovakia has such an extensive commercial liason with the whole world, her traffic will be channeled through various ports according to the forelands. This explains why Czechoslovakian transits pass through numerous ports situated in various regions of Europe; thus our concept of hinterland must be changed and in particular that of the contestable hinterland.

An examination of the economic geography of various regions constituting the hinterland of a number of ports will make it possible not only to delimitate the hinterlands according to the intensity of their traffic with a particular port but also to delimitate the hinterlands according to groups of goods. In Poland for example two articles have been written dealing with forest products and mineral products as an element of the hinterland of Polish ports [2, 4]. Each commodity group may constitute a separate hinterland. The foreland of the port will depend on the intensity and structure of the hinterland. Finally more attention must be given to problems of transport, taking the policy of rate structure into consideration. The problems of railway connections within the national hinterland of the Polish ports has up to now been treated with only little interest [1].

In the further study of the port hinterland it will be necessary to aim at more precise terminology and at the application of new methods of investigation. The methods of statistical description as well as statistical deduction would seem to be insufficient.

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AN ATTEMPT AT COMPUTING AND MAPPING OF THE GEOGRAPHICAL CONCENTRATION OF PRODUCTION FORCES IN POLAND IN 1956

Karol Bromek

The problem of the excessive concentration of industry in the Upper Silesian Coal Basin, which causes certain economic difficulties, has often been raised in connection with the spatial planning of Polish economy. A gradual dispersion of Upper Silesian industry, at least passive, has been suggested, and some investment has already been planned accordingly. At the same time new factories have been built far away from Upper Silesia in places and districts in various parts of Poland, where new deposits have been discovered, or to comply with a new trend for the more even industrialization of Poland. Some economic and technical reasons, however, militate against the dispersion of Upper Silesian industry and encourage the agglomeration of industry in both old and new centres.

What are the results of these adverse economic forces? How should we assess the degree of concentration of industry, as well as the size, trends, and speed in changes of concentration? To answer these questions the author has endeavoured to adapt and expand the existing statistical and cartographic methods. The author is particularly interested in one specific case of concentration, namely the territorial (geographical). He assumes that the geographical character of concentration is represented by the three following spatial criteria: (1) localized concentration; (2) geometrical concentration; (3) concentration in the spatial pattern.

In the first case the statistical population of the whole country, composed of *powiat* elements (units of the administrative division with areas from 318 to 2320 km² and an average of 870 km² i.e. 1/323 part of Poland), has been analysed regardless of the location of agglomeration, exclusively upon the criterion of descending density of population. In the second case the starting point has been the centre of the urban district of Świętochłowice, which has the greatest density of population employed in industry within

Poland's largest industrial agglomeration, the Upper Silesian industrial district, and the statistical population of the whole country has been analysed as a function of the distance from Świętochłowice. In the third case the starting point has also been the town of Świętochłowice, to which other districts of the Upper Silesian industrial district have been added successively, in accordance with the criterion of descending density of population employed in industry and in such a way as to avoid spatial gaps. Outside the conurbation of the Upper Silesian industrial district the spatial pattern of railways running from it in the following directions: –Bielsko-Biała; –Rybnik; –Sudety (Wałbrzych); –Opole–Wrocław–Zielona Góra; –Poznań–Szczecin; –Bydgoszcz –Gdańsk; –Częstochowa–Koluszki (Łódź); –Warszawa–Białystok; Kielce–Ra-

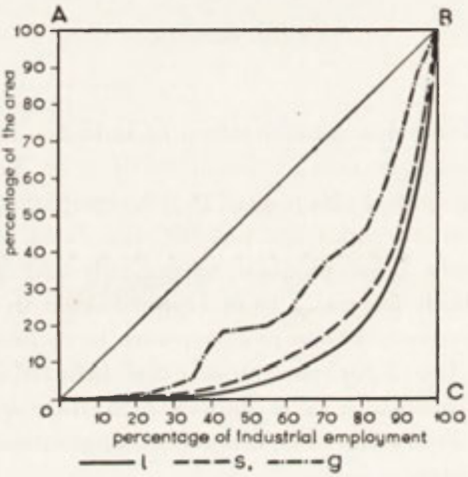

Fig. 1. Curves of the geographical concentration of industrial employment in Poland in 1956
l — localized concentration, s — geometrical concentration, g — concentration in the spatial pattern

dom–Lublin; and Kraków–Rzeszów, has also been investigated. These railways link some smaller agglomerations and industrial centres, as well as bigger towns, and the Upper Silesian industrial district. Most goods and passengers are carried by these lines. Groups of *powiats* have been created along them and their branch lines, in such a way as to form unbroken zones and to secure greatest averages of density (e.g. the zone of *powiats* from Zawiercie to Warsaw). Groups and individual *powiats* have been ranged according to descending density.

Industrial problems have been analysed on the basis of production forces. Three groups of production forces which are mutually interlinked geographically and economically, and which are becoming successively more concentrated, have been investigated; namely (A) the total of population; (B) population employed in industry; (C) population employed in industry A (production of means of production). Existing statistical data permit the analysis of changes in the concentration of these production forces in Poland in 1946, 1956 and 1960, an analysis which should be continued in future. This article describes the methodological experiment for one unit of time only, 1956.

In Polish literature the first analysis of problems of concentration was published by S. Fogelson in 1933 [1]. Then, S. Szulc's handbook of statistics [3, p. 271] gives an example of how to use concentration as a measure in a geographical comparison.

In this study concentration has been measured with the Lorenz curve [2] which is also a graphic presentation of concentration. The ratio of concentration (η), that is the ratio of the area between the straight line OB and the Lorenz curve (e.g. l) to the area of the triangle OBC (Fig. 1) has been accepted as the measure of concentration. It may theoretically vary from 0 to 1.

The Lorenz curves have been based upon a cumulative series composed

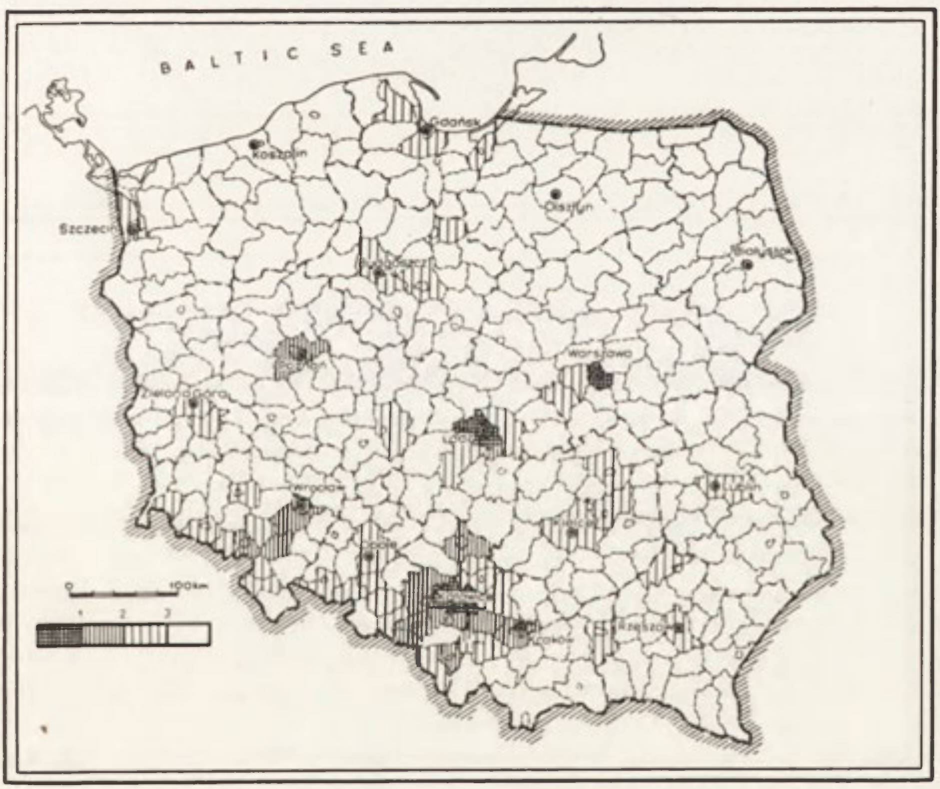

Fig. 2. Employment in industry in 1956. Areas limited by quartiles of the cumulative series of localized concentration
1 — first quartile, 2 — median, 3 — third quartile

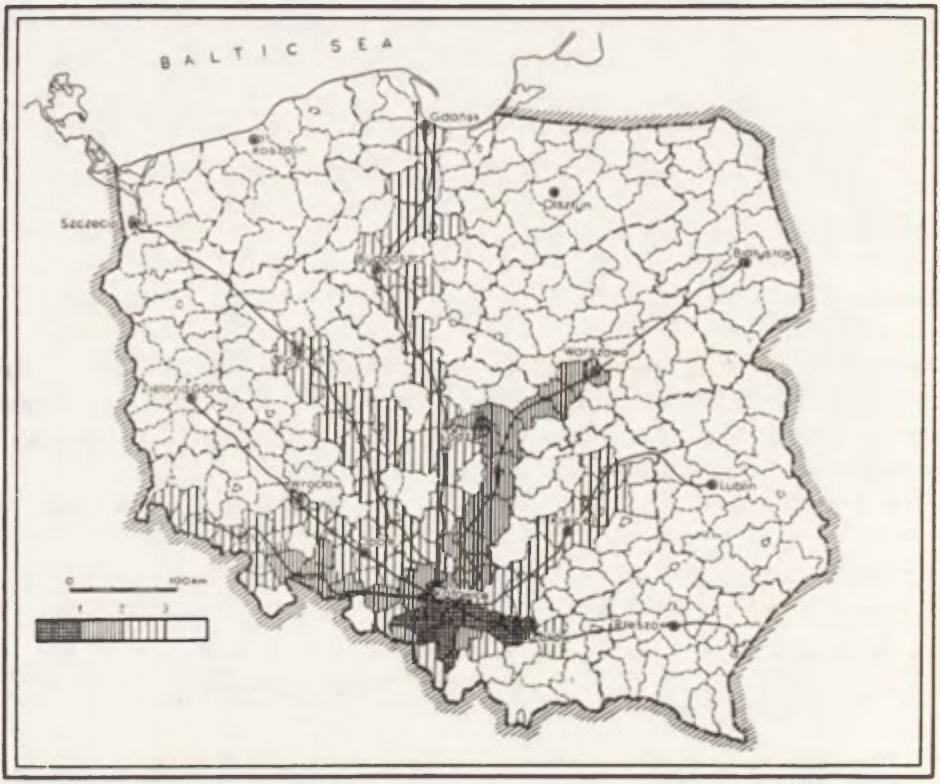

Fig. 3. Employment in industry in 1956. Areas limited by quartiles of the cumulative series of geometrical concentration
1 — first quartile, 2 — median, 3 — third quartile

of 5% of representative agglomerations of production forces (total population, population employed in industry, population employed in industry A) and upon a cumulative series of relevant areas.

The cartographic presentation consists of drawing in on the maps of groups of *powiats*, limited by successive quantiles of the statistical series of geographical concentration of the three representative groups of production forces (total population, population employed in industry, population employed in Industry A) according to the three criteria of concentration (localized concentration, geometric concentration, and concentration in the spatial pattern). As a result, a set of nine maps has been prepared. The three maps included in this publication present a simplified picture of the concentration of the total population employed in industry, drawn by means of quartiles (Figs. 2, 3, 4). The first cartographic presentation of the series of concentrations limited by quantiles was published in Polish literature by F. Uhorczak for the 1946 population of Poland [4].

As shown in Table 1, the ratios of localized concentration (η_l) have the highest values, those of concentration in the spatial pattern (η_s) are intermediate, and those of geometrical concentration (η_g) are the lowest.

TABLE 1. RATIOS OF CONCENTRATION OF PRODUCTION FORCES IN POLAND IN 1956

Agglomeration	η_l	η_s	η_g	$\eta_l-\eta_g$	$\eta_s-\eta_g$	Ψ
(A) Total population	0.39	0.32	0.24	0.15	0.08	0.53
(B) Population employed in industry	0.77	0,71	0.47	0.30	0.24	0.80
(C) Population employed in industry A	0.84	0.77	0.58	0.26	0.19	0.73

Among selected groups of production forces the highest values are to be found in the ratios of concentration of population employed in industry A) production of means of production), the intermediate in the ratios of concentration of population employed in industry, and the lowest in the ratios of concentration of the total population (Table 1). The differences in concentration are great; e.g. the difference between η_l people employed in industry A

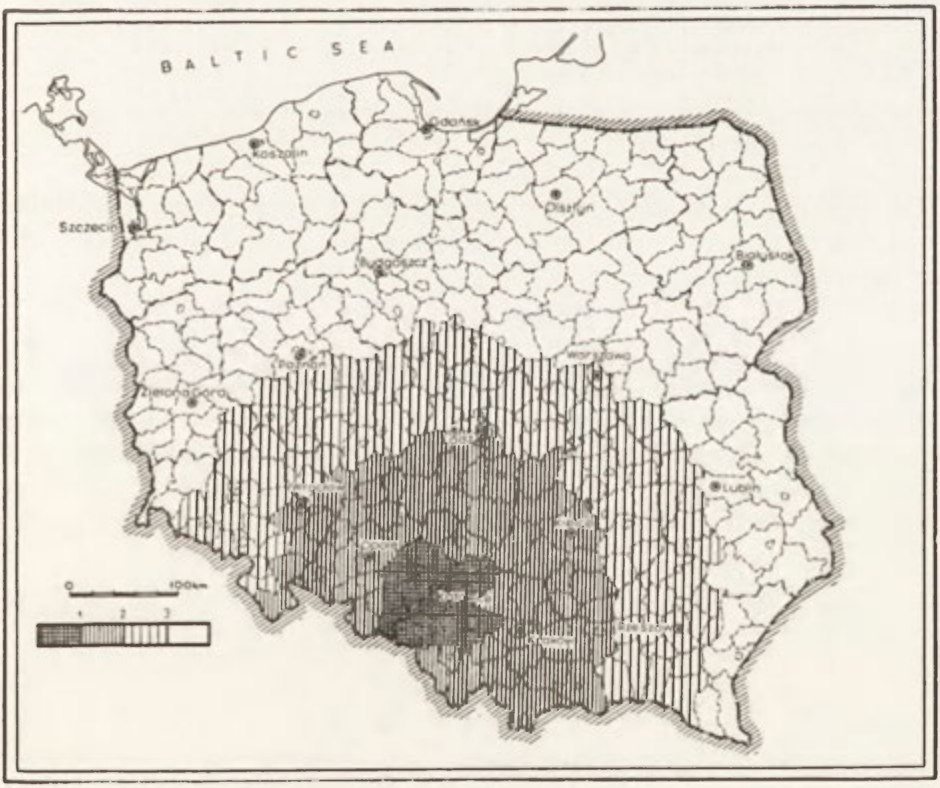

Fig. 4. Employment in industry in 1956. Areas limited by quartiles of the cumulative series of concentration in the spatial pattern
1 — first quartile, 2 — median, 3 — third quartile

and η_l of the total population amounts to 0.45, i.e. it comes close to the median value of the whole theoretical range of the ratios of concentration. This means that great disproportions exist in Poland between the distribution of population and the distribution of the industry of means of production. The difference between η_l of the total population employed in industry, and η_l of the total population is also outstanding; it is high for η_l both agglomerations of industry.

TABLE 2. QUARTILES OF AREA OF CUMULATIVE SERIES OF PRODUCTION FORCES IN POLAND IN 1956

Quartiles	Concentration					
	localized		in spatial pattern		geometrical	
	km²	%	km²	%	km²	%
(A) Total population						
I quartile	12,649	4.1	20,656	6.6	43,732	14.0
median	65,752	21.8	75,949	24.4	105,926	34.0
III quartile	154,511	49.6	158,933	51.0	177,932	57.1
(B) Population employed in industry						
I quartile	1,787	0.6	4,416	1.4	9,103	2.9
median	11,715	3.8	20,139	7.4	60,393	19.4
III quartile	45,640	16.6	67,779	21.7	131,547	42.2
(C) Population employed in industry A						
I quartile	810	0.3	1,028	0.3	2,777	0.9
median	7,469	2.4	13,062	4.2	35,276	11.3
III quartile	26,172	8.4	47,653	15.3	111,776	35.9
Poland	311,730	100.0	311,730	100.0	311,730	100.0

The significance of the spatial pattern in the distribution of production forces can be assessed with the coefficient of the spatial pattern (ψ), which can be conceived as:

$$\psi = \frac{\eta_s - \eta_g}{\eta_l - \eta_g}$$

There is then simultaneously the ratio of the area between the curves s and g to the surface between curves l and g in Fig. 1. The coefficient ψ is the highest in the agglomeration of population employed in industry (0.80), lower in the agglomeration of people employed in industry A (0.73) and lowest in the agglomeration of the total population (0.53).

TABLE 3. RATIOS OF CONCETRATION OF POPULATION EMPLOYED IN INDUSTRY A IN 1946 AND 1956

Years	η_l	η_s	η_g
946	0,89	0,83	0,65
956	0,84	0,h7	0,58
946— 956	−0,05	−0,06	−0,07

The concentration of production forces is also shown in Table 2, comprising quartiles of the area of the three groups of the production forces, corresponding to the three criteria of concentration.

The method of analysing the concentration of production forces worked out for Poland in 1956 is particularly applicable to the time analysis of changes in concentration. Provisional results of the analysis of concentration of people employed in industry A in Poland in 1946 permit conclusions to be drawn as to the trend and relative extent of concentration. On the basis of Table 3 it appears that in the period under consideration there was a notable decrease in concentration, and that the greatest changes occurred in geometrical concentration, and the lowest in localized concentration. Conclusion: the greatest relative changes occurred outside Upper Silesia in some distant territories, and the smallest in the dispersion of industry.

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STUDY OF GEOGRAPHICAL ENVIRONMENT FOR THE PURPOSE OF REGIONAL AND LOCAL PLANNING

Michał Więckowski

The intensive development of physical planning demands from geographers a great number of surveys of applied physical geography, which are necessary for making both regional and local (urban and rural) planning schemes.

Those demands were summed up in a concise way by S. Leszczycki in his paper on applied geography delivered at the Conference of the Polish Geographical Society in Gdańsk, 1962. It was stressed there, that the results of geographical examinations, as well as estimations, and conclusions should be dealt with not only qualitatively but also quantitatively and include, apart from the actual state of the environment, a prognosis of the changes it may undergo in the future. It was also stated that the applied geography surveys should answer two basic questions, i.e. (1) whether the resources of the geographical environment are properly utilized from the standpoint of meeting the present and future demands of the population, (2) how to distribute the population.

The first question refers first of all to the economic aspect of planning, the second — which is more in detail treated here — to local planning.

Different problems and scales of planning imply, that there are essential differences both in aim and scale in surveys of the geographical environment which are necessary for regional and local planning.

In planning the prospective development of national economy — covering the whole country — so as to include regional planning, proper areal distribution of social work, as rational productive relations within and between the regions produce the basic problems. In order to aim at the most economical distribution of production means and services it is necessary to consider not only the actual state of economy and demands connected with growth of population, but also to estimate potential of the area i.e. the natural resources of the area which were not utilized before. The type and volume of these resources as well as the conditions of their exploitation should be estimated from the point of view both of the economy and the protection of Nature.

A certain prognosis is essential in respect to possible changes in the geographical environments, particularelу those which are unfavourable from the point of view of economy and human welfare. Such a prognosis enables certain measures to be found that remove or at least weaken the undesirable phenomena.

Thus in regional planning a physiographic survey is comprised first at all of the particular components of the geographical environments; this being indispensable for estimating the kind and quality as well as quantity of mineral resources, timber resources, water for electrical power generation or even mineral waters, interesting of their restorative value for health.

In local planning a geographer is expected to estimate the utility of various areas for settlement, road network or other kinds of open space planning. It may also be necessary to estimate the properties of various kinds of land; or again to make an analysis of the whole complex of components of the geographical environment, such as contours of the ground related to geomorphological processes and geological structure, water conditions, local climate etc. An exact and full estimate of the said properties is only possible on the basis of an analysis which considers the integrity of the geographical environment.

When analysing and making estimates of the properties of the geographical environment one should consider dynamics of the changes going on constantly within it, and at the same time remember the necessity of assessing the utility of various types of land for different — strictly defined — types of development.

The estimate will certainly only be relative as can be seen from two examples of surveys enclosed in the paper, one for the area of central Poland, the other for the highlands of south-east Poland, since the criteria for estimating utility of land for settlement are different for highlands and for the lowlands.

The economic aspect should also be considered in such estimations. One should take into account the planned utilization of the natural resources and at the same time mark as unsuitable for settlement the areas where mineral, or other resources are found, though their exploitation has as yet not been planned.

A quite specific situation in this respect occurs when estimating the utility of the land for rural settlement. In this case in addition to making a survey for settlement it is necessary to examine utility of the area for agricultural purposes, since whether it is a case of planning a whole rural area or only a single village it should always be done in relation to the place of work i.e. the arable land.

The closest relationship between physiographic problems connected with regional planning and those connected with local planning occurs when economic decisions are made as to the choice of a locality for investment (i.e. general localization) and decisions taken by local planning authorities on the investor's suggestion which refer to localization of the investment in a cnosen site (i.e. specific localization).

The above named relationship is of two kinds:

1. When general localization of the investment connected with utilization of resources is made in an area, it seems necessary to adjust the specific localization and the type of development of the investment area and the neighbouring area to the actual conditions and the changes that will follow the exploitation of the natural resources. In this case it is necessary to supplement the physiographic survey needed for making the local plan with the investor's prognosis of the changes in the geographical environment.

2. If the investment, as in the case of a large industrial establishment, is not connected with utilization of the local natural resources, then — as a rule — several possibilities of general localization are considered. In such a case every variation in general localization demands an estimate of physiographic conditions also from the point of view of specific localization in relation to the local plan of spatial development. Eventually the conclusions drawn

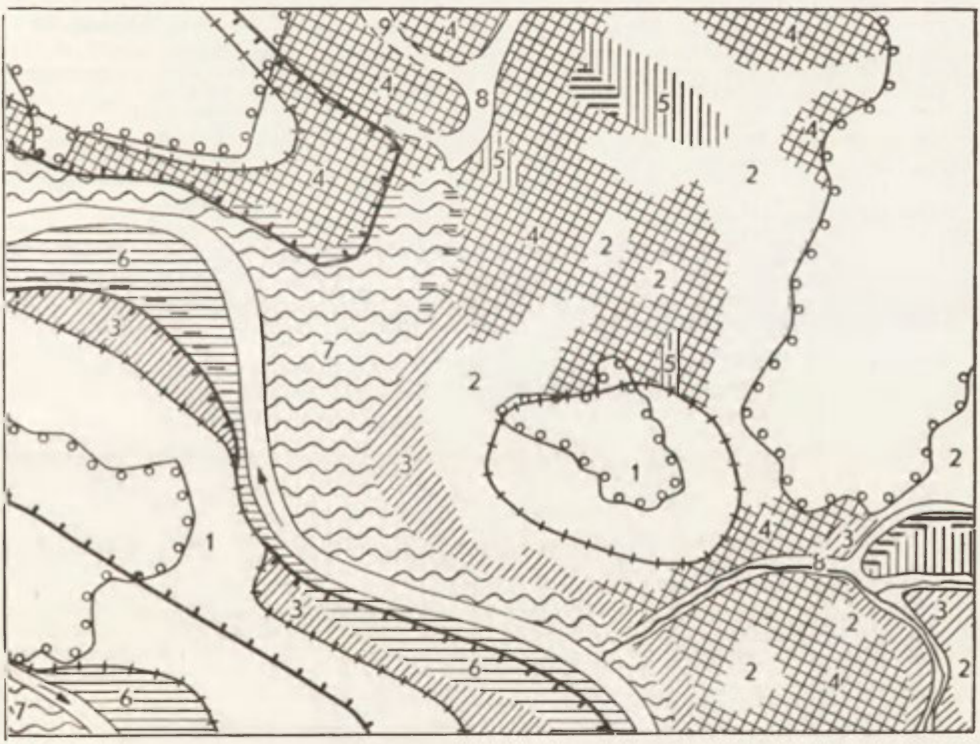


Fig. 1. Estimate of the Conditions of the Geographical Environment (For explanation of signs see page 242-243)

Explanation of signs to Fig. 1.

Estimate of the Conditions of the Geographical Environment

Type of Land		Characteristics of the Type of Land	Estimate of the Conditions of Geographical Environment for Settlement	Conclusions
1	2	3	4	5
Hills		Narrow and long hills of NW and SE direction. Altitude to 900 m above sea level	Not suitable for settlement. Only in places of flattened ridges and on slopes with southern aspect it is possible to build tourist hostels	Recommended afforestation
Uplands and valleys	2	Dome like hills and flattened on top with	Suitable for building and road network	Recommended interfield afforestation
		Flat land and the foot of the slopes	Southern slopes suitable for building	Recommended drainage of bog lands
		Slopes with a strong relief	Not suitable for building	Recommended afforestation
		Slopes, steep rocky faces, undercut by erosion, intensive modeling process	Not suitable for building	Recommended anti-erosive procedures
Valleys		High flood terraces 4-8 m above average river level	Suitable for building in not shaded areas facing the south	Recommended partial amelioration
		Low flood terraces 1-4 m above average river level	Not suitable for building	-
		Small valleys floors often terrace like	Not suitable for building	Recommended planting the slopes with trees
		Upper parts of valleys small valley formations	Not suitable for building	—

Additional signs:

- Forests
- Permanently bog lands
- Interfluent bog lands
- Areas with no possibility of using ground water for drinking and other purposes
- Areas of shifting and creeping
- Rivers and torrents

for Settlement in the Bieszczady Mountains, scale 1:25,000

The Properties of Particular Components of the Environment Affecting an Estimation					
Contour of the Ground	Water Conditions		Climatic Conditions	Ground Conditions	Soil Conditions
	Surface Waters	Underground Waters			
6	7	8	9	10	11
Declivity over 35%, relative altitude 100-300 m, numerous tiny and deep valleys with steep slopes	Numerous narrow currents on slopes, springs, swampy areas	At the depth of more than 12 m from surface	Strongly shaded valleys of high humidity, persistence of snow	On flat lands suitable for building. Uniform rock on the surface or covered with a clay-debris layer 3 m thick	Mountainous soils strongly washed out
Surface declivities 0-5%, on slopes 5-15% scarcely cut by valleys	Surface run off following heavy showers on unpermeable soils in lower parts	At a depth 6-12 m if substratum is permeable	Good insolation and airation	Weathering cover 1-3 m thick in upper layers, 5-20 m in lower layers	Mountainous soils IV, V class
Declivities 5-15%	Frequent local water bogs	At a depth 6-12 m	Depending on exposition	Clay-debris cover 5-20 m thick	
Declivities 15-35%	Run off of rainfall	At the depth below 12 m	Effective at south facing	Thin 1-5 m clay-debris cover	Mountainous soil V class
Declivities 35-100%	Surface run off, intensive washout	-	-	Weathering cover very thin, often uniform rock at the surface	
Declivities not exceeding 5%	Permanent or temporary bogs at the foot of the slopes	At a depth of 1-8 m	Less advantegeous than uplands	Gravels with sandy alluvial soils	Alluvial dusty III, IV class
Declivities not exceeding 50%	Flooded at high water level	At a depth of 0-4 m	Inversion area	River sands and and gravels	Usually VI class
Flat valley floors	Boggy or flooded	Mostly at a depth of 1 m	Flow of cool air, heavy shadow	Clay formations	-
Declivities of different kinds, mostly high	-	At a depth of 1 m	-	-	-

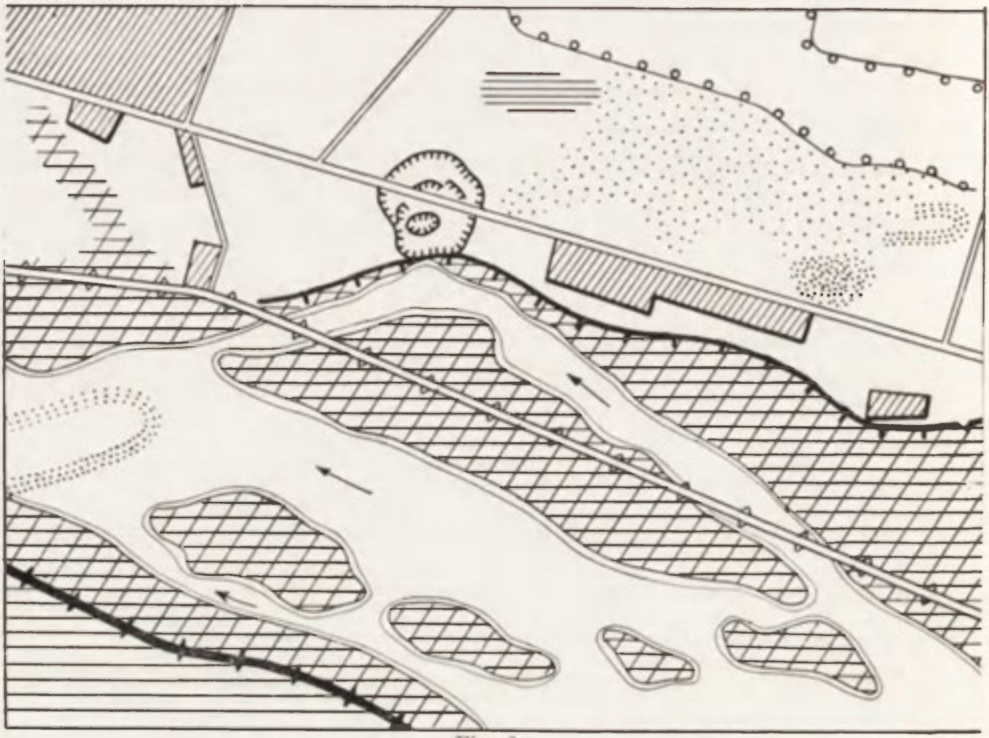


Fig. 2.

Estimate of the Conditions of Geographical Environment for Settlement from the Area of Central Poland
Scale 1:25,000

Areas with prevailing conditions advantageous for settlement:

The majority of flat areas or areas with 1 - 3% declivity. Sand-gravel or clay grounds suitable for settlement. Ground water level beneath 2.5 m.
Climatic conditions favourable. Water supply easy

Areas with conditions less suitable for settlement, which can be improved by certain procedures, however decisions of particular localisation require inspection of the land:

The objections refer to water conditions: ground-water level is less than 2.5 m; the land reguires local drainage before it is built on sandy grounds.
Climatic conditions-average. Water-supply easy

The objections resulting from ground and morphologic conditions, sand dunes occur in the area. A slope gradient of 3 - 7% or higher.
Conditions unfavourable for building

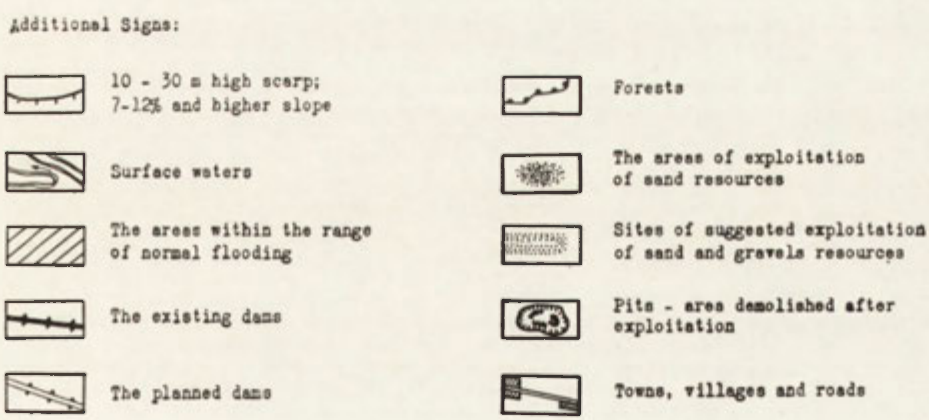
Areas where conditions unfavourable for settlement prevail:

Loam-sandy ground, often peaty and swampy. Ground water level over 1.0 m. Very gentle slopes make drainage difficult. Unfavourable climatic conditions with the possibility of the persistance of cold air and fog. Part of the land lies within the range of normal flooding from the local planning scheme for conditions of specific localization of the investment, and its influence upon the environment (which must be considered in analysing geographical environment) can definitely determine general localization, i.e. the choice of the locality when the investment will be realized.

To sum up, it can be concluded that in regional planning — physiographic surveys comprising first of all the various components of the geographical environment are supplemented with concise estimate of its properties and of the changes it is expected to undergo, whereas in local planning it is necessary to make comparative estimates of the utility of particular areas for settlement, road network etc.

The enclosed maps represent examples of numerous physiographic surveys for local planning schemes comprising complexes of rural settlement units. According to the directions of the Committee of Construction, Town Planning and Architecture, a concise estimate of the conditions of the geographical environments is given there; everything that refers to particular components of the environment is treated as either commentary or motivation of the estimate. In the physiographic atlas that is being worked out as well as in the materials of the regional planning offices most important are the maps of the particular components wihch make possible estimation of various resources.

Committee of Construction,
Town Planning and Architecture
Warszawa



GEOGRAPHIA POLONICA 2,1964

THE FREQUENCY OF THE ECONOMICO-GEOGRAPHICAL GROUPS OF FEATURES USING THE EXAMPLE OF POLAND*

ZBIGNIEW WYSOCKI

Geographical research concerns mainly mass phenomena. The continuous and varying development of the processes of geographical phenomena, has created a great number of combinations of features. In fact it is so great, and gives an impression of such chaos that any taxonomic attempts would be difficult. The question arises of whether the plurality of forms is a phenomenon which is continuous or stepped. In the first case all the combinations of featurs would appear in a random manner. In the latter case some categories of features would repeatedly appear in groups more often than might be anticipated in the light of the theory of probability.

The solution of this problem would have many consequences. It would made possible e.g. progress in the development of geographical taxonomy, by which I mean scientific methods of ordering and dividing the objects of geographical research. As a result it would also enable an extension of the discussion on the essence of the geographical region and the regional method. If it appeared that in an agglomeration of geographical phenomena a steplike frequency of some groups of features considered as taxonomic, exists — then it might be possible to delimit more or less clearly one group from another. Thus, finally it would be possible to have within geography a typological system, which is an essential tool in the process of detecting identity among the infinity of elements in the world of geographical phenomena. This would give geography additional fields of interest and open a so far unknown area of research — geosystematics[1]. If on the other hand this frequency has a conti-

* The first results of this study were reported by Professors J. Czyzewski and S. Golachowski during the meeting of the Science Faculty of Wroclaw Scientific Society, November 23rd, 1961 see *Spraw. Wrocl. Tow. Nauk.*, B, 16/1961, Wroclaw 1962, 23—32).

[1] This idea designates the confrontation of geographical phenomena and their classification. The aim of geosystematics is to include all the elements of the visible surface of the Earth into a typological system. The basis of the system is a causal similarity of forms in the grouping of their features (natural system), or else the simple sum of individual features, which characterize given geographical phenomena (artificial system).

nuous character, which means that actual number of groups of certain categories of features is consistent with the number of groups of all the features and the differences between the two are inessential or that the selection of features was not correct, then the division of geographical populations[2] into parts with similar properties would be a matter of convention.

It is not difficult to study the correlation between two features with the use of tables of association of features. However, it is a more complex problem, when one has to consider more features or to delimit a number of groups with an apparently infinite succesion of possible combinations. Here the patterns of linear dependancy do not exhaust all the possibilities. According to P.A. Samuelson it is possible and permissible to use them only in the field of qualitative regularities [1]. In geographical research one faces the necessity to compare qualitative features of different value which always and in every place have their quantitative equivalent. Features with such qualities, especially in large numbers, create patterns of correlation which are very complex from the statistical point of view. Here the regression of empirical variables has the shape of a curve contrary to two-dimensional populations, where the regression has a shape of a straight line. Linear regression is more easy to grasp and requires less intricate computations than curvilinear regression. One can find a way out of the difficulties of studying multi-dimensional populations by changing from a comparison of different situations during different periods of time to quantitative studies on dynamics of various combinations of individual features according to their size. This could be done by computing and comparing the frequency of repetition of definite degrees of features in groups.

The present author has chosen a problem of the Polish economy in order to verify a hypothesis according to which different features of the same phenomena are interdependent. This interdependency is more or less limited but always determinable. In order to realize the geographical structure of the national economy — a system of 5 indices (in short the system of *RIMPT*) was introduced. This system is to serve as a measure of the development of the regional economy in this country. The frequency of coappearance of the indices in groups has been examined.

The indices are as following:

1. Index of the social structure of rural areas

$$R = \frac{L_r}{H_g} D,$$

[2] The term "population" is used here in the statistical meaning. It refers to agglomeration of units under discussion.

where:

L_r % of people working in agriculture and living on farms,

D % of members of farmers' families who commute to non-agricultural jobs,

H_g % of consumers living on farms not included into D.

2. Index of intensity of agriculture

$$I = \frac{\Sigma pQ_r \, \Sigma \, qQ_z}{Z},$$

where:

p % of agricultural land under field crops (excluding grains) and meadows and pastures,

Z % of agricultural land under grains,

Q_r index of intensity of crop production,

Q_z index of intensity of husbandry,

q number of large animals per 100 ha of agricultural land.

Thus the totals, $I_r = \Sigma \, pQ_r$ denotes the intensity of all the crop production and the totals $I_z = \Sigma \, qQ_z$ the intensity of all the husbandry.

3. Index of the size of the internal market

$$M = K \frac{H}{S},$$

where:

H the number of the inhabitants,

S the area under discussion in km²,

K $\frac{H_m}{L_r}$ = the relation of the urban population to farmers.

This index defines the certain extent of demographic density.

4. Index of industrialization

$$P = k \frac{(L_p + L_m)}{S},$$

where:

k energy capacity in kW in relation to the population of the area,

L_p employment in industry,

L_m employment in handicrafts.

Thus, the coefficient k defines to what extent the population is working in mechanized manu facturing on the given area.

5. Index of the density of the communication network

$$T = \frac{\Sigma t}{S},$$

where Σt = the total length of railway lines and improved roads in km.

Deductive conclusions pertaining to selection and evaluation of the above mentioned indices were based on the idea of a morphological perpendicular. It is obvious that the regional organization of human society and its economy, are subject to evolutionary changes. They develop from original simpler forms, into newer more highly organized ones. Consequently this author took the concept of the human environment as beeing a continuous process from agriculture and more dispersed settlement to industry with more concentrated settlement. Thus to the traditional two-dimensional geographical analysis, a third dimension — that of time has been added. The indices *RIMPT* are supposed to represent the general location of a given area within a hierarchical pattern of vertical geographical phenomena, and define its topographical location.

Basic data were grouped together for 328 territorial divisions, which niclude all the completely rural *powiats* as well as rural *powiats* which are comsbined with urban ones. The author considered separately 5 city-voivodshipt and the Upper Silesian industrial district. All the *powiats* were analyzed a- units of a statistical population and the established indices as features, thas is to say as random variables.

Consequently the system *RIMPT* was used as a five-dimensional random variable. Each *powiat* was an individual point of a five-dimensional space. Originally only the first four features of a system were taken into account, since the population under discussion was too limited for this method of classification of structures. The analysis was also based on the assumption that individual *powiats* differ one from the other not in their features but in the gradation of their features. Thus, each index was later subdivided into three categories according to its average deviation (σ). Consequently all the multi--dimensional space is subdivided into 3^4 cubes. The division of features into parts is more or less optional. It depends on the size of the population and on the number of analyzed features.

For each of the cubes a tensor was computed. This is a theoretical (*Lt*) and existing (*Lf*) coexistence of individual categories of features in groups. The latter was obtained by computing equally marked individual points (points of multi-dimensional space). *Lt* was obtained on the basis of an equation for complex probability

where:

$$Lt = \frac{S_1 \cdot S_2 \cdot S_3 \cdot S_4}{N^{n-1}},$$

S_1 *Lf* of an index *R* in a given grade of its quantity

S_2, S_3, S_4 *Lf* of indices *I*, *M*, *P*,

N number of units analyzed.

After computing the absolute surplusses and deficits between *Lf* and *Lt* ($Lf - Lt$) a number of cases for each of the 81 ($\Sigma = 3^4$) possible combinations of features was obtained. These combinations were subsequently arranged according to the last difference: 1111, 1112, 1113, 1121, 1122, 1123, 1131 etc. All this population was later arranged according to the combinations, in the above mentioned lexicographical order. Eventually a test χ^2 was used according to the formula

$$\chi^2 = \sum \frac{(Lf - Lt)^2}{Lt},$$

and the theoretical frequency of groups of features was compared with that empirically obtained in order to find out whether and to what extent the variables (features) are independent. Typical points of multi-dimensional space were chosen, in which the value χ^2 is larger than the critical one, defined by the index of importance (in this study = 3.84).

The criterium χ^2 defines only the statistical importance of a surplus and does not take into account its sign. In this analysis however only positive surplusses and their values are of importance. Consequently, this criterium does not give any assesment of the strength of features within a group. Therefore in computing important positive surpluses, where $\chi^2 > 3.84$ an additional limitation was introduced. This is a relative surpluss

$$W = \frac{Lf - Lt}{Lf} \cdot 100,$$

where Lf and Lt denote known frequencies of the groups *RIMP*.

The method of analysis of the frequency of coexistence of features in groups is known in scientific literature thanks to A. Wanke as a method of stochastic multiple correlation [2].

As a result of having used this method it was found out, that there are two groups with greatest frequency of coexistence of categories of features *RIMP*. These groups are anthitetically opposed. The first is a combination of 1111 marked as *N* — which is characteristic of structures with a weakly developed economy. The second — a combination of 3333, denoted as *W* is typical of well developed forms of economy, mainly in industrialized areas. The index *T* also tends to coexist more often with the groups *N* and *W* in the first and third category. The frequency of occurance of the different degrees of value of *T* were computed for all the groups of features *RIMP* with positive and meaningfull surpluses. As a result for groups *N* and *W* new combinations of features of a system *RIMPT*: 11111 and 33333 were obtained.

To visualize a similarity of groups *N* and *W* in the structure of each *powiat*, these groups (individual points in five-dimensional space) were accepted as fiducial points in a method of computing typological complexes in the *powiats*. The distances of all the 328 units from these fiducial points, were computed from the equation

$$C\left[\left(\frac{1}{d_1}\right)^q + \left(\frac{1}{d_2}\right)^q + \ldots + \left(\frac{1}{d_n}\right)^q\right] = 1,$$

where:

$d_1, d_2,..$ distances from fiducial points,

q the number of independent variables,

C the ratio which transforms all the components of the total into per cent.

In spite of this, the establishment of typological complexes in *powiats* was still difficult due to the strong irregularity in distribution of the features. Therefore all the indices of *RIMPT* were normed according to the range

$$Z_i = \frac{X_i - \min. X_i}{\max. X_i - \min. X_i} \cdot 100,$$

where X_i empirical value of a normed feature,

Z_i normed value.

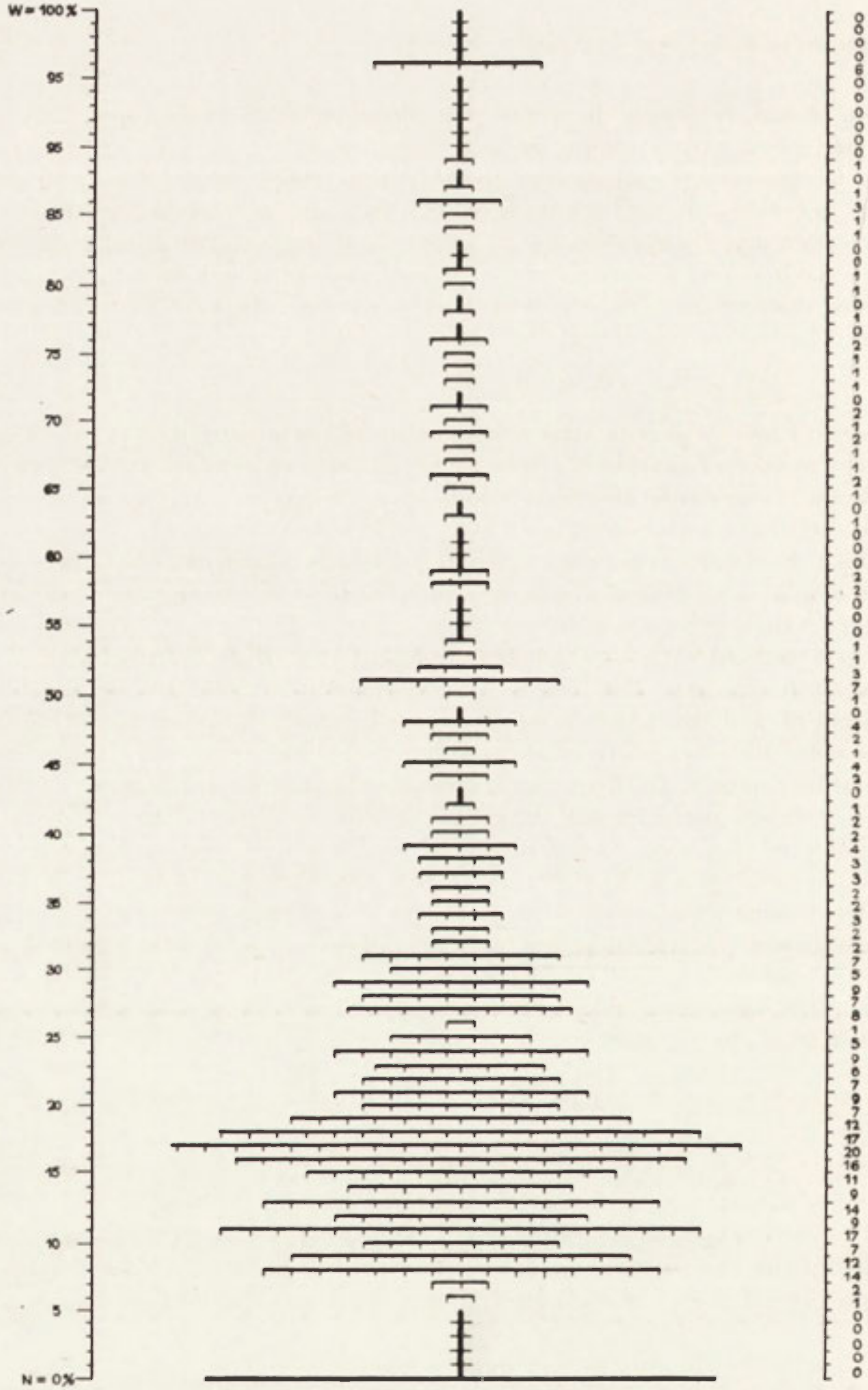


Fig. 1. Arrangement of *powiats* according to the system of S indices of economic development (RIMPT) from type N (=0%) to the type W (= 100%)

The results of the analysis were plotted on a graph of normed *powiats* on a perpendicular line of distribution of 5 indices of economic development. This graph resembles hierarchical pyramid. Horizontal segments departing from the perpendicular line represent by their length the number of units of analyzed population (*powiats*) within a given distance of earlier defined typological elements (groups *N* and *W*) in %. The perpendicular is divided into 4 equal parts, which correspond to the different levels of economic development in the country. The highest division includes administrative units situated in the best developed, industrialized areas while the lowest division weakly developed, mainly agricultural types. Intermediary forms in both the medium divisions are classified accordingly. Striking concentration of 204 *powiats* in the lowest division reflects the underdevelopment typical of the structure of space economy in Poland.

The map gives a geographical picture of similarity of *powiats* as regards defined typological elements. It is a synthesis of the topographical distribution of the indices *RIMPT*. On the map groups of *powiats* were delimited, where one particular typological element dominates.

The cartographic principles consist of an interpolation of the indices of economic development. A point of reference was always located in the centre of the *powiat*. Consequently, the interpolated lines represent the geometric positions of the indices of location of *powiats*, in typological space defined by groups *N* and *W*. As such they are real phenomenon. However, time also exerts an influence. All the values of which these lines consist are only relatively permanent. In order to express the content of such a theory of lines, with an equal level of economic development the term iseconoms has been proposed. In the present study this term is a basic notion. It states indirectly movement in the economy, it reflects the dynamics of changes which occur in economic structures on the surface of the Earth.

Four large and some smaller territorial units with similar features of economic development can be seen on the map. Neither are geographic regions in traditional meaning of the term. Consequently, there is no historical justification for the term. They are structural units of the forms of spatial economy in the country. Their shape and structure reflects the scale of territorial-dynamic gradations in the total structure of the national economy of Poland. In order to avoid any misunderstanding over regions, they were marked by the letters A, B, C, D in an order of decreasing economic activity.

Location of these units reflects a sharp contrast of structure of economy between the eastern and western parts of Poland. Beginning from the iseconom 20 between territorial units B and C_2 the intensity of economic life decreases eastwards. It also drops northwards from A to B and C_1; however this latter drop is not so sharp. Consequently, the iseconom 20 was accepted as the main line defining the differences of economic development in Poland.

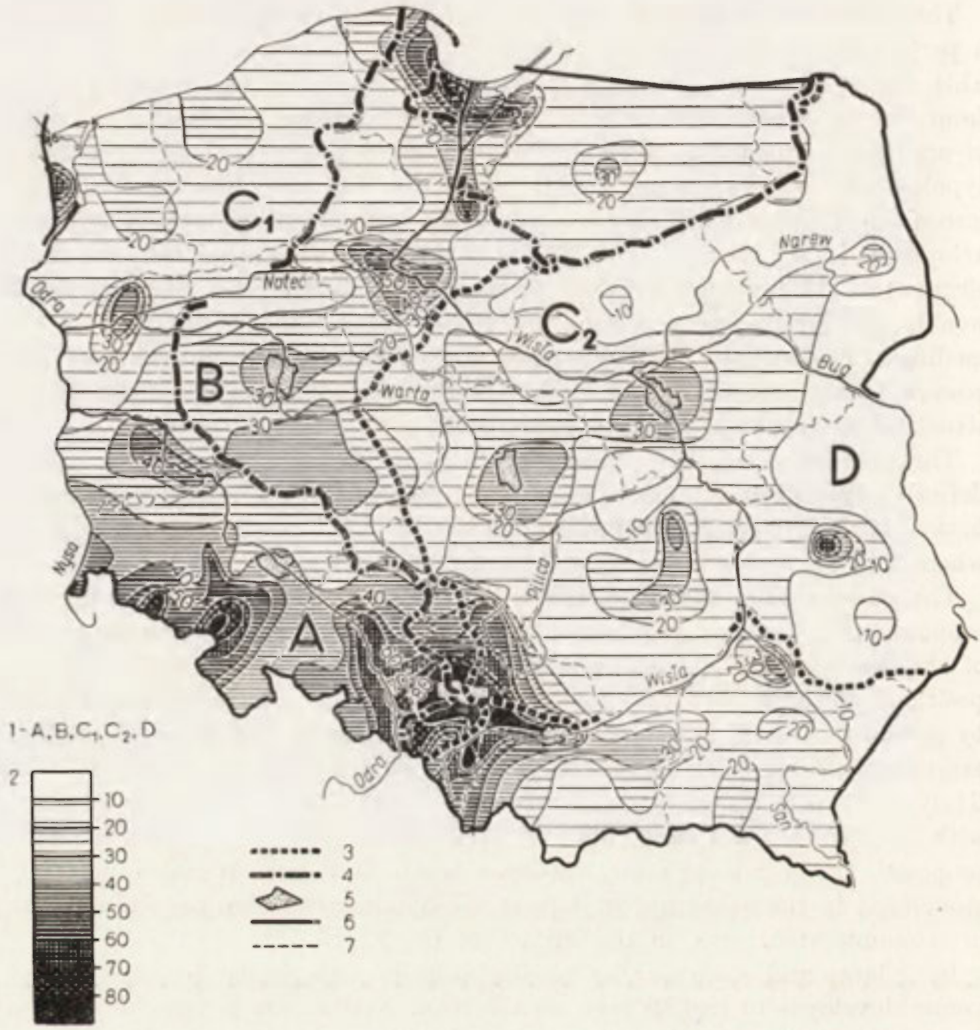


Fig. 2. Economic territories in Poland

1 — main units of the structure of spatial economy, 2 — similarity of economic development of *powiats* to the types N and W (in %), 3 — international boundaries during partition time, 4 — international boundaries in 1939, 5 — largest urban concentrations, 6 — boundary of Poland in 1945, 7 — limits of voivodships

It divides the areas B from C_2. It indicates the traditional division of the country into a better developed West and still relatively underdeveloped East. Within the postwar limits the continuation of this differentiation was stated here for the first time in an exact way.

The location of lines of the same level of economic development suggests several geographic directions for further development e.g. the Lower Vistula valley or the S. and S.W. parts of the country.

In the "Polish East" two areas strongly contrast one with another — first the area within the arch of the Vistula from Cracow to Toruń and secondly the area east of the Vistula. The former area forms a central economic region of Poland and its importance is constantly increasing.

The map also shows to what extent traces of old political boundaries can be seen in the spatial economy of the country. This can particularly be seen in the East, since in the West the vestiges of the old political disruptions have to a greater extent been erased. A demonstration of these facts in the economic geography of Poland is considered by the present author as one of the basic scientific contributions of this study.

The present approach to mass geographic phenomena using geometric techniques has opened new possibilities of geographic research. It enables us now to make territorial-dynamic analysis of all the possible combinations of interrelations between geographical phenomena according to the probability of these of these interrelations. So far such an analysis has created many difficulties. Particularly difficult was defining the limits of mutability in the forms of grouping of the phenomena on the surface of the Earth. It is reflected in questions, often appearing in geographic literature such as — when can one start to define a country as "industrial", "agricultural" or of "mixed economy". What should be the unified system of gradation?

The above method applied in geographic research is very suitable for distinguishing unity amongst plurality. As a result it is also possible to solve in a general way different problems which otherwise would be treated separately. Applied to the problem of regionalization the method proves that the pattern of geographical phenomena approximates more to an order than to chaos. Another problem refers to the stability of the forms of grouping the geographical phenomena at different levels in a hierarchical order. Still another question is connected with the pattern of iseconoms on the territory of neighbouring countries and the rest of the European continent.

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References

[1] Samuelson P.A., *Foundations of economic analysis*, Cambridge 1948, XII, 447 pp.

[2] Wanke A., *Częstość zespołów cech antropologicznych* (Fréquence des combinaisons des caractères anthropologiques), Prace Wrocl. Tow. Nauk., ser. B, 29, Wrocław 1952, 58 pp. Communicate: Fréquence des combinaisons des caractères anthropologiques, *Comptes-rendus de la Société des Sciences et des Lettres de Wroclaw*, 4(1949), Wrocław 1955, pp. 57-59.

[3] Wanke A., "Zagadnienie typów somatycznych" (Sum. Problems of the Somato-Types), *Przegl. antropol.*, 20(1954), pp. 64-96. Communicate: Problème des types somatiques, *Comptes-rendus de la Société des Sciences et des Lettres de Wroclaw*, 7(1952), Wrocław 1957, pp. 74-81.

GEOGRAPHIA POLONICA 2,1964

MORAINES AND DUNES ON SMALL-SCALE MAPS

Stanisław Pietkiewicz

The contrast between large, mountainous relief features on the one hand and small sub-montane or pre-montane plateaux and hillocks on the other often induces cartographers to concentrate their attention and creative efforts on the first and to neglect the others. Even in the leading atlases, considered irreproachable in regard to relief representation and prepared under the direction of well-known cartographers, this bias is often apparent. In hypsometric atlases this is due mostly to the rigidity of the section system, but even in cartographic works with more elastic methods of presenting relief, small features are shown much less clearly than the properly characterized large features.

Moraines and dunes — largely intricate forms, difficult to generalize about, and small not so much in height as in the space occupied in the plan — present particular difficulties for the cartographer and are among the most neglected features, though they often occur in masses and over large areas. Cartographers are sometimes completely at a loss in regard to them, as was already pointed out[1]. Frequently, however, these features not only dominate the landscape of whole regions, but also influence the economy, the viability, the settlement and the whole spatial pattern of human work in these regions.

Some features in this category are commonly presented in atlases because they are well known or because they are shown by a generally used contour line. The moraine blocking Lake Garda from the south answers both these conditions. It dominates the lake and the lowlands by 100 to 180 m and is outlined by the 100 m contour line. Almost all European atlases, reference or school, depict it clearly (Figs. 1-4).

Similar moraines on the northern Alpine border are generally presented less well (Figs. 6, 8), although their relative heights are only slightly smaller and the areas on which they form the characteristic hilly landscape are even

[1] Cf. Salishchev K.A., *Osnovy kartovedenya*, I(1944), p. 154, and Meshcheryakov, *Izv. Akad. Nauk SSSR, ser. geogr.* (1954), 4, p. 62 and 71.

greater. This landscape, not properly presented in any of the reference atlases, is shown correctly only in two German school atlases, in which both hypsometry and either hachuring (Fig. 7) or shading (Fig. 9) are used. It is obvious, however, in the last figure, that the authors did not achieve their object immediately. The hypsometric design alone hardly showed these features (Fig. 8).

The delineation of moraine relief on lowlands, where it often dominates morphologically, constitutes an even more important problem. Here also many cartographical representations have failed. Mecklenburg, for example, according to British and Soviet hypsometric atlases (Fig. 10), seems to be completely flat, and in the hatched atlas (Fig. 11) hillocky only in several places. In reality it embraces a whole compact complex of glacially modelled forms (Fig. 12) which can be presented hypsometrically if a sufficiently dense section system is used (Fig. 13).

The International World Map (Fig. 14) has also failed in the presentation of moraine relief because of a too loose section system, although this relief has been adequately presented on a similar map one and a half smaller in scale but drawn with twice the section density (Fig. 15).

None of the great atlases presents the hillocky relief of the North-American lake region in the vicinity of the Great Lakes adequately enough (Fig. 16, 17). Only the network of meltwater channels is visible to a certain extent in the publications of the Edinburgh Geographical Institute, and in the new edition of the American school atlas (Fig. 18).

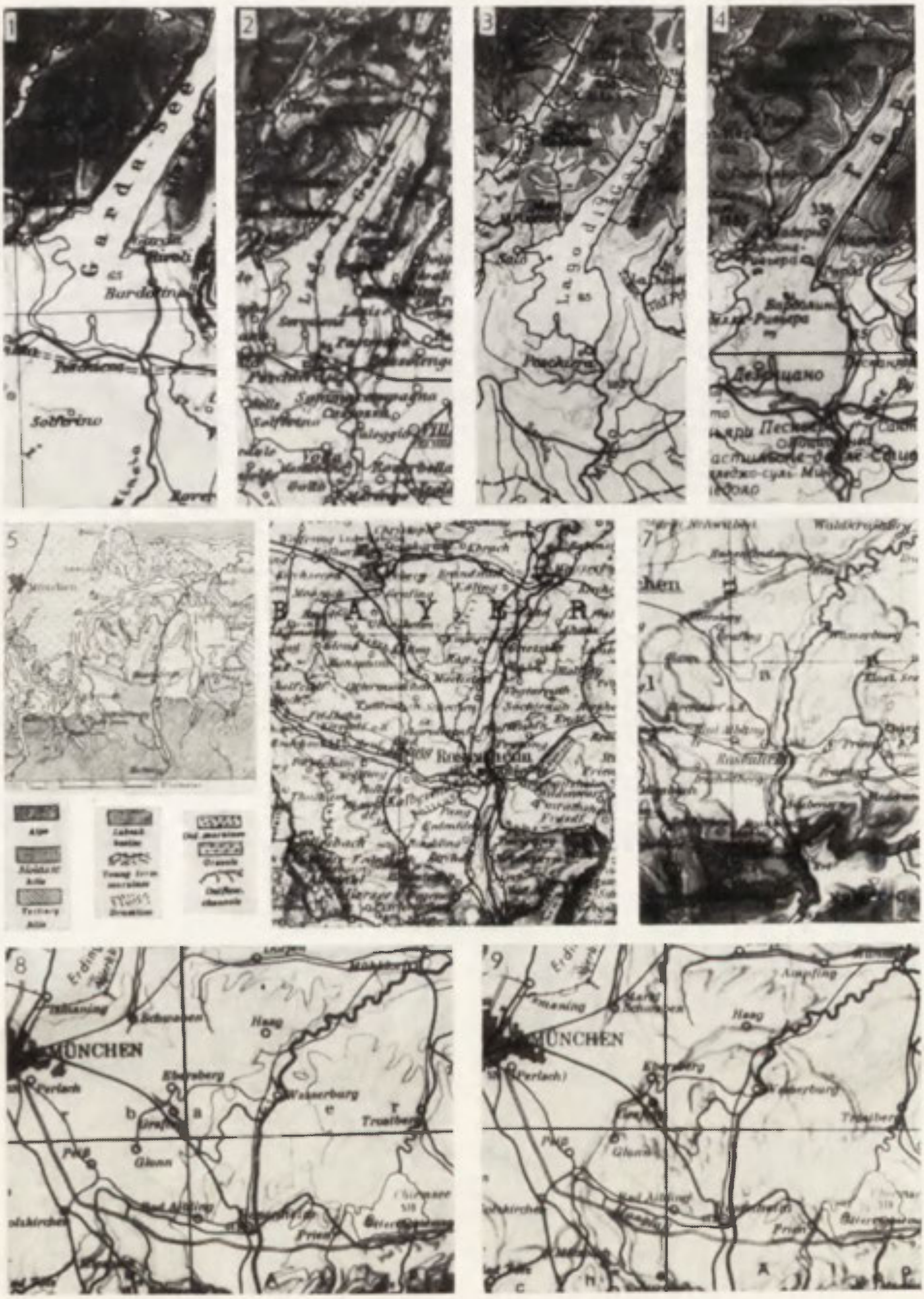
In our attempts at a cartographic presentation of the features of Central-European moraine landscapes we have tried to show the culminating groups and ranges of hills as well as the outlet channels of meltwaters traversing them (Fig. 19). Generalizing hills by linking them together into larger units — as has been suggested in an otherwise excellent study by Dr Horn of Gotha[2] — proved, however, to be unsuitable. The enlarged picture of hills can of course be recommended, but even the generalized presentation of the whole must clearly show that the rise is composed of a great number of individual hills. At the same time it is necessary to show the direction in which the hills have tended to develop corresponding to the flow and the stops of the former glacier; as well as the spatial character of the groups of these hills.

Passing to dunes, the only ones presented in existing atlases are wandering dunes in deserts (Fig. 20); but their various patterns creating whole zones quite different in landscape or viability are not distinguished. Quite recently two Soviet wall maps, and also the new Atlas of the Soviet Union[3], have shown these zones in a form similar to aerial photographs (Figs. 21, 22).

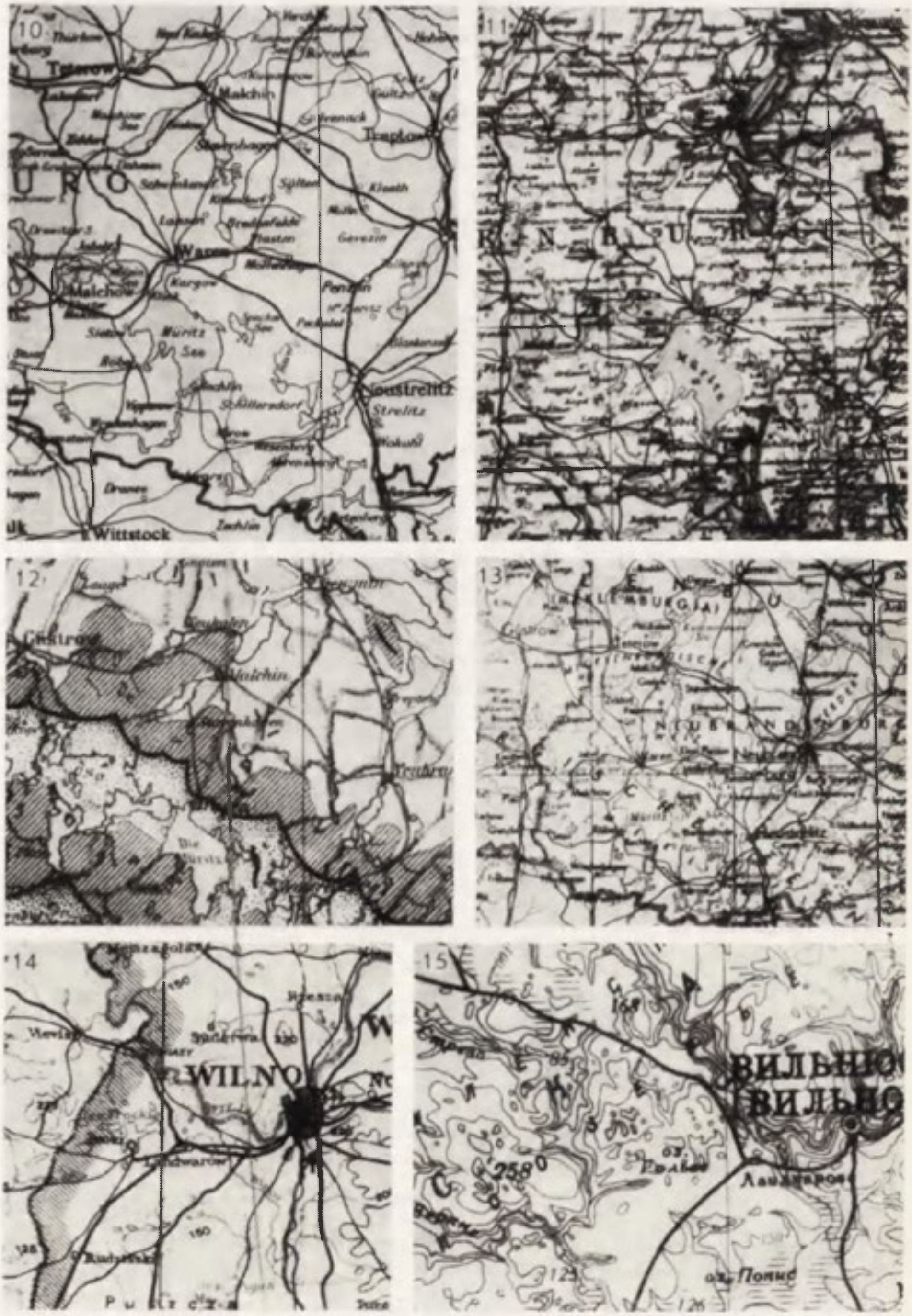
[2] „Das Generalisieren von Höhenlinien für geographische Karten", *Petermanns geogr. Mitt.* 91 (1945), 1-3, pp. 31-46.

[3] *Atlas SSSR*, Moskva 1962 (pl. 22-31).

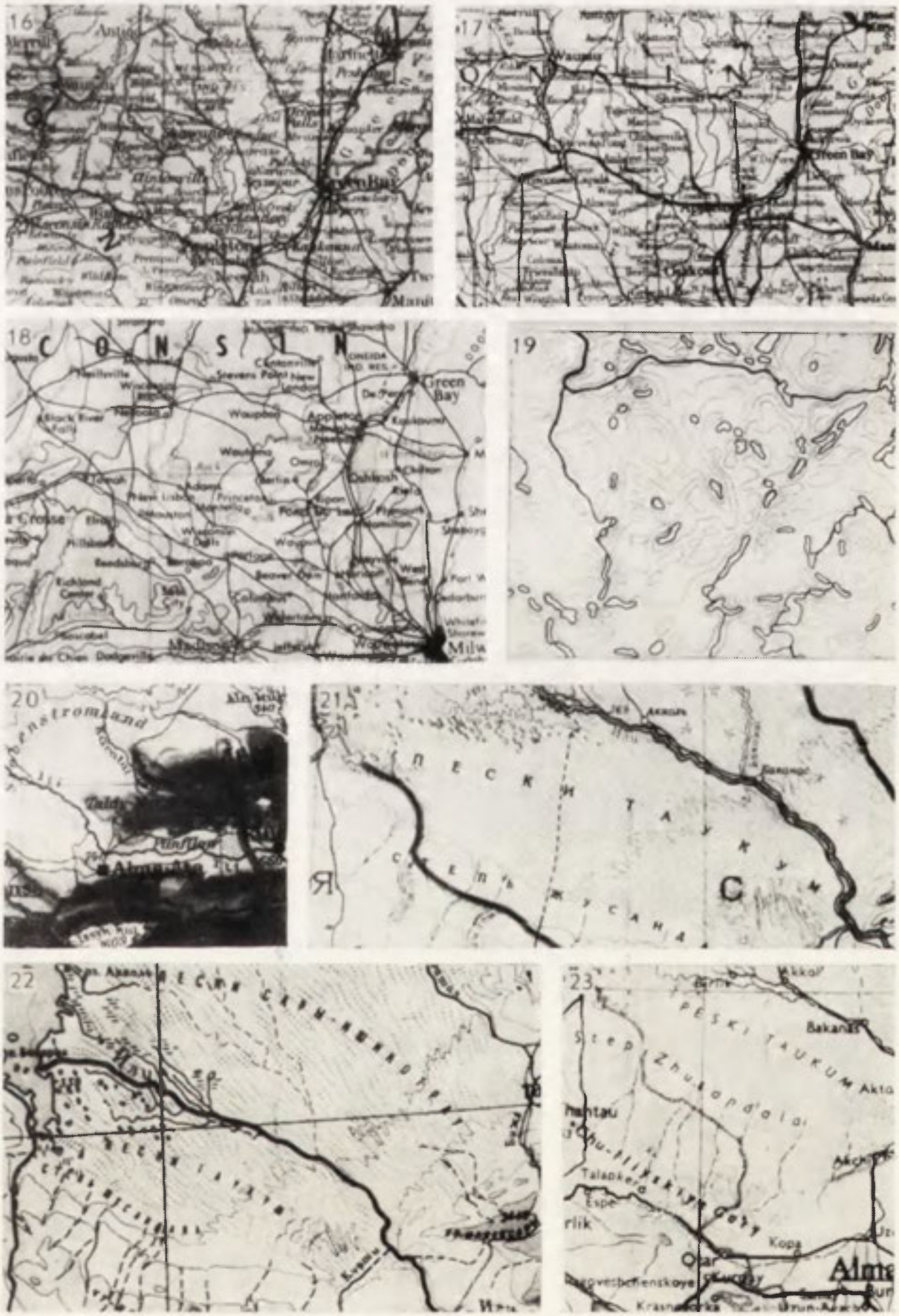
PLATE I



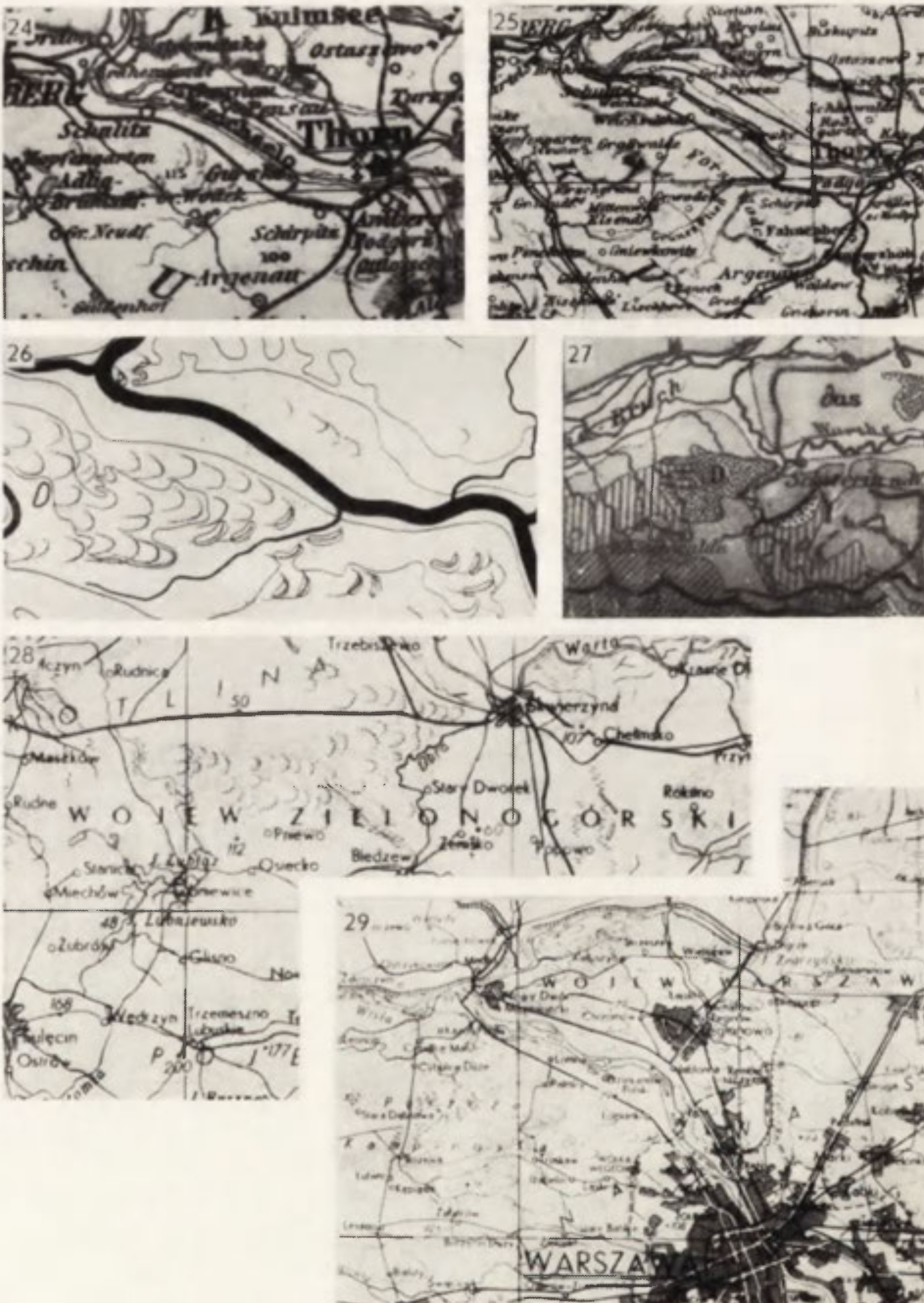
1 — Garda Lake in Diercke's School-Atlas (enlarged edition), 2 — Garda Lake in Stieler's Hand-Atlas (1925 edition), 3 — Garda Lake in Atlante Internazionale del Touring Club Italiano, 4 — Garda Lake in Atlas Mira (Moskva 1954), 5 — Bavarian moraines SE from Munich, after Hettner, 6 — Bavarian moraines SE from Munich in Stielers Hand-Atlas, 7 — Bavarian moraines SE from Munich in Dierke's enlarged atlas, 8 — Bavarian moraines SE from Munich in Slanar's-Lautensach's Atlas zur Erdkunde, 9 — Bavarian moraines SE from Munich in Slanar's-Keyser's Welt-Atlas (Vienna-Heidelberg 1962)



10 — Eastern Mecklenburg in Times Atlas, 11 — Eastern Mecklenburg in Stieler's Hand-Atlas, 12 — Eastern Mecklenburg, morphology after Woldstedt, 13 — Eastern Mecklenburg in Atlas Świata (Warszawa 1963), 14 — South-Eastern Lithuania on the International Map of the World, 15 — South-Eastern Lithuania on the Soviet Hypsometric 1 : 1,5 million map



16 — The State of Wisconsin in Atlante Internazionale del Touring Club Italiano, 17 — The State of Wisconsin in Times Atlas, 18 — The State of Wisconsin in Goode's World Atlas, 11th ed. (1960), 19 — Moraines of middle Pomerania on a Polish school wall map, 20 — Turkestan dunes in Diercke's Atlas, 21 — Turkestan dunes on the Soviet academic wall-map „Pamir i Tyan-Shan" (Moskva 1951), 22 — Turkestan dunes on the 1 : 4 millions hypsometric map of the U.S.S.R., 23 — Turkestan dunes in Times Atlas



24 — Toruń dunes (middle Poland) in Stieler's Hand-Atlas, sheet 7, 25 — Toruń dunes (middle Poland) in Stieler's Hand-Atlas, sheet 19. 26 — Toruń dunes (middle Poland) on a Polish school wall-map, 27 — Dunes of the lower Warta valley on Woldstedt's morphological map: D = dunes, ∂as = higher terrace, ∂ = morainic plateau, 28 — Dunes of the lower Warta valley in Atlas Świata (Warszawa 1963): Kotlina = basin, POJ. = Pojezierze = lake plateau, Puszcza = forest. 29 — Dunes of the Warsaw Basin in Atlas Świata (Warszawa 1963). For explanation of terms see Fig. 28

This is obviously a better way of expressing reality than that currently used in atlases, which combines the old dot symbol with contour lines, reflecting these forms only on the border of the hypsometric degree (Fig. 23).

The diversity of the shapes of dunes on the sea coast and also within the continent of Europe have often attracted geographers and geologists in this part of the world (Deecke, Hogbom, Jentzsch, Keilhack, Kádár, Lencewicz, Solger, Sokolov, Tutkovsky, and others), but these forms were considered too small to find expression in atlases. How little attention has been paid to them, is clearly visible by comparing two maps from one of the leading 19th century atlases (1925 edition) presenting the same territory of inland dunes (Figs. 24, 25).

We have lately tried to use a symbol similar to that used in the above mentioned Soviet maps to delineate the stabilized inland dunes of the European lowlands. We have thus succeeded in presenting the differentiation and distribution of these forms quite clearly on 1:500,000 and 1:750,000 scales and on 1:250,000 wall maps. It proved possible to mark them even at half this scale when a similar but somewhat finer symbol is used (Figs. 26, 28, 29).

It seems that by proceeding further along these lines a cartographic standard of presentation of the features in question can be obtained which, while not deviating too far from the generally accepted customs, at the same time secures an accuracy and expressiveness similar to that in geomorphological maps, and in so doing enriches the content of atlas and survey maps with a geographical element of the utmost significance. In the Netherlands, in the Vistula delta, and in the French Landes the dune walls are after all the main component of the shore, and should be clearly distinguished on the maps of these regions, as are cliffs, emerging sandbanks (Watts), and rocks elsewhere. In the interior, groups of dunes often influence the localization of watersheds and thus must be taken into consideration on hydrographic maps. Unfit for cultivation, they form sparsely populated, afforested, or waste lands. As they influence the course of running waters and the patterns of settlement and transport, moraines as well as dunes should be included in the detailed atlas maps and survey maps.

Geographical Institute
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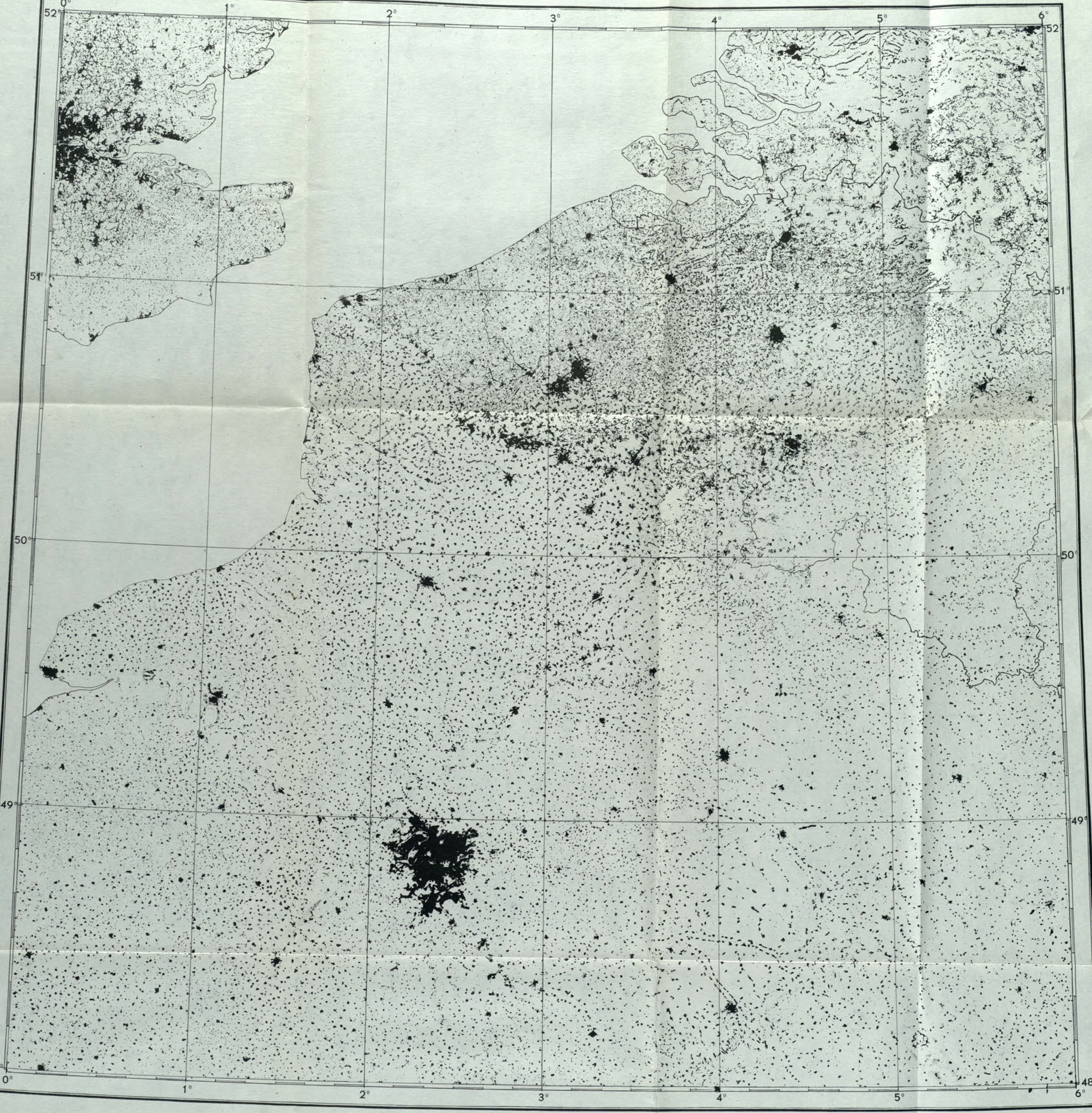
MAPA OSADNICTWA ŚWIATA
WORLD SETTLEMENT MAP

1:1000 000

PARIS

WYDANIE TYMCZASOWE
PROVISIONAL EDITION

NM — 31



KATEDRA KARTOGRAFII
UNIWERSYTETU MARII CURIE-SKŁODOWSKIEJ W LUBLINIE

MAPA OSADNICTWA ŚWIATA

OPRACOWANA WEDŁUG METODY I POD KIERUNKIEM
Prof. dr FRANCISZKA UHORCZAKA

ARKUSZ PARIS OPRACOWAŁA BOGUMIŁA WOŁOSZYN
DO DRUKU PRZYGOTOWAŁ mgr JAN KOZŁOWSKI

DEPARTMENT OF CARTOGRAPHY
MARIE CURIE-SKŁODOWSKA UNIVERSITY LUBLIN, POLAND

WORLD SETTLEMENT MAP

PREPARED AFTER THE METHOD AND UNDER THE DIRECTION
of Prof. FRANCISZEK UHORCZAK Ph.D.

THE SHEET PARIS WAS PREPARED CARTOGRAPHICALLY
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PODZIAŁKA — SCALE 1:1 000 000

km 10 0 10 20 30 40 50 60 70 80 90 100 km

Osadnictwo wyznaczone przy pomocy ekwidystanty 75 m od zabudowań — Settlement area includes 75 m zones from buildings

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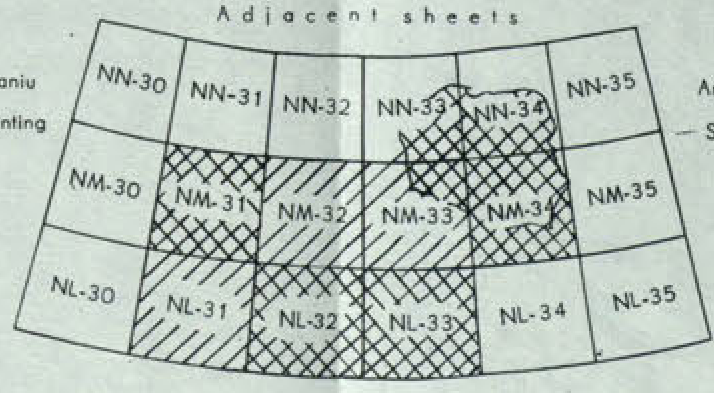

1:30 M

Granice polityczne
International boundaries

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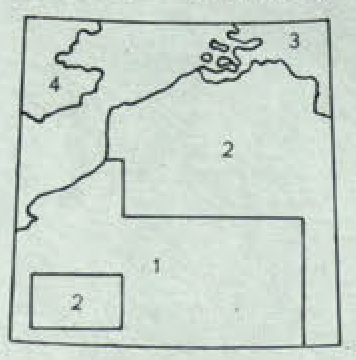

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1 Carte de France et des frontières a 1: 200 000 (type 1912—1942)
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